

In Binding, observe to place,

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Jan. 11. 1725-26.

I Have read this Book, and
think it will be very useful
to Beginners.

J. T. Desaguliers,
L. L. D. F. R. S.

A N
I N T R O D U C T I O N
T O
Geography, Astronomy,
A N D
D I A L L I N G :
Containing the most
U s e f u l E L E M E N T S
Of the said
S C I E N C E S,
Adapted to the
M e a n e s t C A P A C I T Y,
By the DESCRIPTION and Uses of the
Terrestrial and Cœlestial G L O B E S :
With an
I n t r o d u c t i o n t o C H R O N O L O G Y .

T H E S E C O N D E D I T I O N .

In which, besides many other great ADDITIONS,
are about Twenty PARADOXES belonging to the
G L O B E S , intirely New.

As also, The Construction and Uses of Refracting
and Reflecting T E L E S C O P E S , &c.

By G E O R G E G O R D O N .

L O N D O N :

Printed for A. B E T T E S W O R T H , at the *Red-Lyon*
in *Pater - Noster - Row*.

M.DCC.XXIX.

INTRODUCTION
TO
Geography, Astronomy
AND
DIALLING:
Containing the most
Useful ELEMENTS
OF THE ARTS
SCIENCE
MEANING OF ASTRONOMY



Introduction to Chronology

The Second Edition
in which, besides many other great Additions,
are about Twenty Tables, belonging to the
GLOBES, namely, New
As also, The Construction and Use of the
and Rectifying Tables.

BY GEORGE GORDON

LONDON:
Printed for A. MILLAR, in Pall Mall.
MDCCLXXII. 1772.



To the Noble, and Right Honourable
Sir ROBERT WALPOLE,
Knight of the most Noble ORDER
of the *GARTER*,
Chancellor of the EXCHEQUER,
AND
First Commissioner of the TREASURY.

S I R,



T is a great Happiness
when Persons of your
exalted Station and
Merit are pleased to be P A-
T R O N S and E N C O U R A G E R S

A 3

of

vi *DEDICATION.*

of useful and solid Learning; and therefore, since you have been so good as to countenance my Endeavours, I have taken the Liberty to inscribe the following Sheets to your great Name, hoping that the Dignity of the Subject will procure a Pardon for my Presumption.

ASTRONOMY and CHRONOLOGY having been esteemed (in all Ages) as Sciences the most worthy to be cultivated, not only for the Beauty of Speculation, but for their Usefulness to Mankind, to
con-

DEDICATION. vii

contemplate the Glory of God,
which the Heavens declare ;
to examine his Handy-work
in the Firmament, by the
Help of those Instruments,
which bring them near to
our Sight, and enlarge our
View, and to consider his
Wisdom, by comparing to-
gether the Magnitudes, Di-
stances, Courses, and Causes,
of the Motion of the Cœlestial
Bodies, have been from Time
to Time the Employment of
some of the best and greatest
Men, who have generally made
use of the Knowledge gained
by this Science, to settle

viii *DEDICATION.*

CHRONOLOGY; without which, the History of Nations, and ancient Records of greatest Empires, would become almost useless; and since Kings and Princes have been **C**HRONOLOGERS, I hope a good Statesman will not disdain those Sciences as a Diversion, which he might be inclined to make his Study, if his Love for his Country, did not induce him to prefer the Service of the Publick to the highest Gratification of himself.

Here,

DEDICATION. ix

Here, according to the Custom of Dedications, I should draw the Picture of my PATRON, and though the utmost of my Skill would be unequal to the Task, yet the many excellent Qualities that offer themselves to view, would furnish my unskilful Hand with Materials sufficient to give a grateful Idea to all my Readers, but to him, whose Character I should draw: A PATRIOT, who has been so habituated to worship God and defend Religion, to pursue the Interest of his King and Country,

x DEDICATION.

Country, and to do generous and charitable Acts, practises Virtue, without perceiving the Splendor it reflects on him, and would be offended at those that should offer to hold up a Glass, for him to behold his own Lustre.

All that I shall say, therefore, is, that I think my self bound to wish, that you may long continue to shine with the same apparent, as well as inherent, Lustre; and at last, when you leave this transitory World, you may die full of Satisfaction as to your Life
past,

DEDICATION. xi

past, and finally assured, that
you shall be rewarded, and
eternally blessed in a better.
I am,

Great S I R,

Your most humble,

and most devoted,

Servant,

Geo. Gordon.

DEDICATION

pass and finally assured, that
you shall be rewarded, and
eternally blessed in a better
life.
I am,
Yours most devotedly,
Geo. Gordon

Yours most devotedly,
Geo. Gordon



THE

PREFACE.



THE following Sheets were drawn up, and put into this Method, for the Use of some young Persons of Distinction, for whose tender Years, Systems of Geography, and of the Cœlestial Physicks would have been too hard a Study: And the Benefit which they reap'd by those Instructions, encourag'd me to publish them for the Use of Beginners. The Subject

xiv P R E F A C E.

Subject being the Principles of GEOGRAPHY and ASTRONOMY, I presume, needs no Commendation: Because the greatest and most eminent Persons in all Ages have made it their highest Concern to understand it.

And that the Principles of both might be the more easily represented to our Views, the Ancients have recommended (and the Moderns come into) the Use of the GLOBES; of whose Excellency all that I shall say is, that they exceed all other Instruments, as they represent the Heavens and the Earth in their proper and genuine Figures, and therefore ought to be the first Study a Learner should undertake; for without a competent Knowledge of them, he will not be able to understand any Author that treats of GEOGRAPHY, ASTRONOMY, NAVIGATION, or DIALLING, &c. therefore, my Design in this TREATISE, was to make the Use of them plain and easy to the meanest Capacities.

P R E F A C E. xv

To the Principles of GEOGRAPHY and ASTRONOMY, I have added a COMPENDIUM of CHRONOLOGY, the Usefulness of which I cannot better recommend than in the Words of the Learned Mr. Locke, who thus expresseth himself in his extraordinary Thoughts concerning EDUCATION:

‘ With GEOGRAPHY, (says he)
‘ CHRONOLOGY ought to go Hand in
‘ Hand, I mean the general Part of it,
‘ so that he may have in his Mind a
‘ View of the whole Current of Time,
‘ and the several considerable Epochas
‘ that are made use of in History :
‘ Without these two, History, which is
‘ the great Mistress of Prudence and
‘ civil Knowledge, and ought to be the
‘ proper Study of a young Gentleman, or
‘ Man of Business in the World ; with-
‘ out GEOGRAPHY and CHRONOLOGY,
‘ I say, HISTORY will be very ill re-
‘ tained, and very little useful, but be
‘ only a Jumble of Matters of Fact,
‘ confusedly heaped together, without
‘ Order

xvi P R E F A C E.

Order or Instruction; It is by these, that the Actions of Mankind are ranked into their proper Places of Times and Countries, under which Circumstances they are not only much easier kept in the Memory, but in that natural Order, are only capable to afford those Observations which make a Man the better for reading them.

With GEOGRAPHY, (says he)

CHRONOLOGY ought to go Hand in

Hand, I mean the general Part of it,

so that he may have in his Mind a

View of the whole Current of Time,

and the several remarkable Epochs

that are noted in History.

E R R A T A.

Page 58. Line 5. for Longitude read Latitude, p. 164.

l. 10. f. 600000 r. 474000, p. 179. l. 5, 6, and 9.

f. Plan r. Place, p. 257. l. 22. f. Semidiameter r. Diameter.

civil Knowledge, and ought to be the

proper Study of a young Gentleman, or

Man of Business in the World; with-

out GEOGRAPHY and CHRONOLOGY,

I say, History will be very ill re-

trained, and very little useful, but be

only a jumble of Matters of Fact,

confusedly heaped together, without

Order.



COMPENDIUM

OF COSMOGRAPHY:

Containing

The Principles of GEOGRAPHY
and ASTRONOMY.

SECT. I.

Definitions of the Terrestrial Globe.

DEFINITION I.



A GLOBE, or *Sphere*, is a round solid Body, every Part of whose Surface is equally distant from a Point within it, called its *Center*, and it may be conceived to be formed by the Revolution of a *Semicircle* round its *Diameter*. Every Point in the Circumference of the generating

B

rating

2 *A Compendium of Cosmography.*

rating *Semicircle* in its Circumvolution upon its *Axis*, marks out a Circle in the Surface of the *Sphere*; those Circles are greater or lesser, as they are more remote from, or nearer to the Extremities of the *Axis*; that Circle, which is formed by that Point of the *Semicircle*, which is equally distant from the Extremities of the *Axis*, is called, *A great Circle of the Sphere*: All the rest, which are parallel to it, are *Lesser Circles*. Hence all the great Circles of the *Sphere*, cut it into two equal Parts; and the lesser, cut it into unequal Parts.

When such a Body as this hath all the Parts of the *Earth* and *Sea*, drawn or delineated on its Surface, like as in a *Map*, and placed in their natural Order and Situation, it is called the *Terrestrial Globe*. But if on its Surface it hath the fixed Stars, and the Figures of the *Constellations* drawn, it is then called the *Celestial Globe*. An Observer placed on this *Earth*, by extending his Sight every Way equally, if not hindered, bounds the World by a spherical Surface concentrick with himself (that is, with the *Earth*,) and judges all remote Objects, whose Distance is unknown, to be placed, as it were, in the same Concave Spherical Superficies, though they be really very unequally removed from one another. For once then, we shall imagine the *Heavens* and *Earth* to be two concentrick *Spheres*; and then, whatever Circles we suppose in the *Heavens*, we may conceive Circles

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cles in the same Position with Relation to one another on this *Earth*: So the same Circles may be described both on the *Celestial* and *Terrestrial* Globes.

The more remarkable great Circles on the Globes are these: *viz.*

- | | | |
|-------------------|--|---------------------------|
| 1. The Equator, | | 5. The Equinoctial Co- |
| 2. The Horizon, | | lure, |
| 3. The Meridian, | | 6. The Solstitial Colure, |
| 4. The Ecliptick, | | 7. The Vertical Circles. |

The more remarkable lesser Circles are, the two *Tropicks* and two *Polar Circles*.

Def. II. Every Circle is divided, or supposed to be divided into 360 equal Parts, called *Degrees*, and every *Degree* into 60 equal Parts, called *Minutes*. Two Points 90 Degrees distant on each Side of any great Circle are called its *Poles*.

Def. III. The *Axis* is an imaginary Line, passing through the real Globe, and is represented in the artificial Globe, by that Wire on which it turns; the Extremities of the *Axis* are the *Poles* of the *Equator*, and if the *Axis* be imagined to be extended both Ways, 'till it reach the *fixed Stars*, it will touch those Points called the *North* and *South Poles*, or the *Arctick* and *Antarctick Poles*.

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Def. IV. The *Equator* is a great Circle passing from *East* to *West*, dividing the *Terrestrial* Globe into the *Northern* and *Southern* Hemispheres, and the Plane of this great Circle extended every Way, till it meet the fixed Stars, will give us what we call the *Equinoctial* in the *Heavens*; its Poles are the same with the Poles of the *World*, as in Fig. 1. where *Æ Q*, represent the *Equator*, *P* the *North*, and *P* the *South Poles* of the *World*.

Def. V. The *Plane* of a Circle is that *Surface* on which it is drawn, or on which it is imagin'd to be drawn, and if that *Surface* be extended, or imagin'd to be extended, infinitely from the Center of the said Circle every Way, without being bended, it is still said to be the *Plane* of that Circle; and all Circles drawn, or imagin'd to be drawn on that *Surface*, are said to be in the same *Plane*: But those Circles are said to be in different *Planes*, when the *Surfaces* on which they are drawn, cross one another, or are inclined to one another.

Def. VI. The *Horizon* is that great Circle which divides the visible from the invisible *Hemisphere*. When it is considered as a great Circle, it is what we call the *Rational Horizon*: But Geographers call so much of the Earth's Surface as is taken into the Eye (the Eye being turn'd round to all the Points of the Compass, with the circular Termination of that Vision)

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Vision) by the Name of the *sensible Horizon*. It is a moveable Circle, having the *Zenith*, or Point over the Observer's Head, and the *Nadir*, or Point under the Observer's Feet for its *Poles*.

The Rational *Horizon* is represented by the wooden Circle encompassing the artificial Globe. In the upper Plane whereof are several Circles delineated. The first or inner Circle is divided into 12 equal Parts, representing the 12 Signs of the *Zodiack*, and every Sign is divided into 30 equal Parts, or Degrees, and numbred with 10, 20, 30.

Next to the Circle of Signs is a *Calendar*, according to the Old Style used in *England*, called the *Julian* Account, which is divided into the 12 Months of the Year, every Month being sub-divided into a respective Number of Days, whereunto is annexed the Festival Days. And by Inspection, the Degree of the *Ecliptick* the Sun is in, for any Day in the Year may be known.

Next is a *Calendar* of the *Gregorian*, or New Style, now used in most foreign Places, instituted by Pope Gregory XIII. in which the Months begin 11 Days sooner than they do in the other.

The last is a Circle of the Winds, divided into 32 equal Parts, called Points of the Compass, by which the *Navigators* design the Quarters of the Heavens, and the Coast and Bearing of Countries. The *Horizon* is represented in Fig. 1. by the Circle H. O.

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Def. VII. The *Meridian* is a great Circle passing through the *Zenith* and *Nadir*, and the *Poles* of the *Equator*, lying directly *North* and *South*, perpendicular to the *Equator*, dividing the *Globe* into the *Eastern* and *Western Hemispheres*; it is also a moveable Circle, having the *East* and *West* Points for its *Poles*. The artificial *Globe* is hung in a brazen Circle, which passes thro' the *Poles* of the *Equator*, that any Point of the *Globe* being brought to that Circle, it may represent the *Meridian* of that Point.

Geographers have fix'd upon one *Meridian*, from which they reckon the Distances of all other *Meridians*, and this they call the *First Meridian*. The *Meridians* usually described on the *Terrestrial Globe*, are 24 *Semicircles*, terminating in the *Poles*; besides which, we may imagine as many as we please. Upon the *Brass Meridian* is fitted a small *Brass Circle*, whose Center is the *North Pole* of the *Equator*, and is divided into 24 equal Parts, representing the *Hours* of the *Day* and *Night*, which, in the Revolution of the *Globe*, are pointed to with an *Index*, which is fitted to the *Pole* of the *Equator*; its Use is to shew the Time of the Rising and Setting of the *Sun*, *Moon*, or *Stars*, and the Time of *Day*, in any Part of the *World*.

Def. VIII. The *Ecliptick* is a great Circle, cutting the *Equator* at Angles of $23^{\circ} 29'$; therefore

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therefore the *Poles* of the *Ecliptick* are distant from the *Poles* of the *Equator* in the *Solstitial Colure* $23^{\circ} 29'$. It is divided into 12 *Signs*, and each *Sign* into 30 *Degrees*: The Names and Characters of the *Signs* are as follow, viz.

<i>Jan in</i>			
<i>March</i>	<i>Aries</i>	♈	<i>Libra</i> ♎
	<i>Taurus</i>	♉	<i>Scorpio</i> ♏
	<i>Gemini</i>	♊	<i>Sagittarius</i> ♐
	<i>Cancer</i>	♋	<i>Capricornus</i> ♑
	<i>Leo</i>	♌	<i>Aquarius</i> ♒
	<i>Virgo</i>	♍	<i>Pisces</i> ♓
			<i>Dec?</i>
			<i>Jan'y</i>
			<i>Feb.</i>

Def. IX. The *Meridian* which passes thro' the first of *Aries* and *Libra*, is called the *Equinoctial Colure*; and that which passes thro' the first of *Cancer* and *Capricorn*, is called the *Solstitial Colure*; the *Poles* of the *Equinoctial Colure* are the two Points where the *Solstitial Colure* cuts the *Equator*; and those of the *Solstitial Colure*, where the *Equinoctial Colure* cuts the *Equator*.

Def. X. Vertical, or *Azimuth* Circles, are great Circles perpendicular to the *Horizon*, and passing thro' the *Zenith* and *Nadir*, as the *Meridians* do thro' the *Poles* of the *Equator*. That *Vertical* which passes thro' the *East* and *West* Points of the *Horizon*, is called the *Prime Vertical*. These Circles are not drawn on Globes, but are represented by the *Quadrant of Altitude*, which is a thin Plate of

B 4

pliable

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pliable Brass, made to skrew on the *Zenith* of any Place, and to reach to the *Horizon*, being divided into 90° , for numbering the Altitude of the Sun or Stars when they are not on the *Meridian*. But when one of the *Poles* of the *Equator* is in the *Zenith*, then the *Meridians* are *Vertical*, or *Azimuth Circles*.

Def. XI. Latitude is the Distance of a Place from the *Equator*, and is either *North*, or *South*, numbered in *Degrees* on a *Meridian*: The brazen *Meridian* is divided into four *Quadrants*; the two upper *Quadrants* are divided each into 90° , and numbered from the *Equator* to the *Poles*; the other two *Quadrants* are numbered from the *Poles* to the *Equator*. On the two upper *Quadrants*, the *Latitudes* of Places are numbered, and on the under *Quadrants*, their Distance from the *Poles*, and is represented in Fig. 1. by Z, H, N, O.

Def. XII. Longitude is the Distance of the *Meridian* of any Place, from the first *Meridian*, and is reckoned upon the *Equator*, either *East* or *West* from the first *Meridian*; but seeing the *Meridians* intersect one another in the *Poles*, and all Circles being supposed to be divided into 360° , it is plain, that a Degree of *Longitude* upon any Parallel of *Latitude*, is of a lesser Extent than a Degree upon the *Equator*, and the nearer you approach to the *Poles*, the lesser they are; therefore the Miles equal to a Degree of *Longitude*, in any *Latitude*, is
in

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in Proportion to the Distance of that Place from the Equator.

N. B. Every Degree of a Great Circle contains 69,5 Miles, according to the latest and best Observations; therefore a Degree of Longitude under the Equator, contains 69,5 Miles, and the Degrees in the several Parallels, are in Proportion to the said 69,5 Miles, according as they are nearer to, or farther removed from, the Equator, as may be seen in the following TABLE.



TABLE

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A TABLE shewing how many Miles go to a Degree of Longitude in any Parallel of Latitude, allowing 69,5 Miles to one Degree of a Great Circle.

°	Miles	°	Miles	°	Miles	°	Miles
0	69 05	23	63 98	46	48 28	69	24 91
1	69 48	24	63 05	47	47 04	70	23 74
2	69 45	25	62 99	48	46 51	71	22 63
3	69 04	26	62 47	49	45 00	72	21 46
4	69 33	27	61 91	50	44 67	73	20 32
5	69 24	28	61 37	51	43 73	74	19 16
6	69 11	29	60 77	52	42 79	75	17 98
7	69 00	30	60 19	53	41 83	76	16 81
8	68 82	31	69 57	54	40 84	77	15 61
9	68 06	32	58 94	55	39 86	78	14 44
10	68 44	33	58 42	56	38 86	79	13 26
11	68 22	34	57 62	57	37 85	80	12 06
12	67 97	35	56 97	58	36 82	81	10 87
13	67 72	36	56 23	59	35 08	82	9 67
14	67 43	37	55 51	60	34 75	83	8 47
15	67 13	38	54 77	61	33 69	84	7 01
16	66 82	39	50 01	62	32 62	85	6 06
17	66 46	40	53 16	63	31 56	86	4 85
18	66 11	41	52 45	64	30 46	87	3 64
19	65 07	42	51 66	65	29 37	88	2 43
20	65 31	43	50 83	66	28 26	89	1 20
21	64 88	44	49 99	67	27 15	90	0 00
22	64 54	45	49 14	68	26 04		

Def.

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Def. XIII. All Circles parallel to the *Equator* on the *Terrestrial Globe*, are *Parallels of Latitude*, the most remarkable of which, are the two *Tropicks*, and the two *polar Circles*. The two *Tropicks* are those of *Cancer* and *Capricorn*, the former being $23^{\circ} 29'$ distant from the *Equator*, and is represented by S , S *Fig. 1.* towards the *North Pole*, and the latter, at the like Distance towards the *South*, represented by M , M . The two *polar Circles* are distant, the one from the *North*, the other from the *South Pole* of the *World*, $23^{\circ} 29'$. The *North Polar Circle* is represented in *Fig. 1.* by the Line ab , and the *South* by xy .

Def. XIV. The *Earth* is divided, in respect of the various Degrees of Heat and Cold, into five *Zones*, viz. Two *Frigid*, two *Temperate*, and one *Torrid*. The *Torrid* lies between the two *Tropicks*, divided by the *Equator* into two equal Parts; the two *Temperate* lie between the two *Tropicks* and *Polar Circles*; that is, the *North Temperate Zone* lies between the *Tropicks* of *Cancer*, and the *North Polar Circle*. And the *South Temperate Zone* between the *Tropick* of *Capricorn*, and the *South Polar Circle*. The two *Frigid Zones* lie between the *Polar Circles* and the *Poles*. The *Torrid Zone* is divided into those Parts that lie under the *Line*; those on the *North Side*, and those on the *South Side*.

Those

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Those Places which lie under the *Equator*, have this peculiar to them, That they have two *Summers*, two *Winters*, two *Springs*, and two *Autumns* each Year. This first is while the *Sun* moves from the first of *Aries*, to the second of *Taurus*, from *March* the 1stth, to *April* the 12th ; *Autumn* from thence to *June* the 10th ; *Winter* from thence to *August* the 9th ; *Spring* from thence to *September* the 11th ; their second *Summer* from thence to *October* the 12th ; their second *Autumn* ends *December* the 11th ; their second *Winter*, *February* the 9th ; their second *Spring*, *March* the 11th.

All Places in the North Side of the *Torrid Zone*, end *Autumn*, and begin *Winter*, at one and the same Time, viz. *December* the 1stth, the *Sun* having then the greatest Meridian Distance from them ; but all the rest of the *Seasons* they begin at different Times ; for their *Summer* begins when the *Sun*, in his Return towards the *Tropick* of *Capricorn*, becomes vertical to them, which must be to different *Parallels* of *Latitude*, at different Times ; their *Summer*, I say, beginning then, must commence at different Times, in different *Latitudes*. The End also of *Summer*, and Beginning of *Autumn* ; as also the End of *Winter*, and Beginning of *Spring*, will be at different Places, in different Times, because in different *Latitudes* the *Sun* will, at different Times, obtain a middle meridional Distance from the *Zenith* of the Place. The Case is the same in the South Side of the *Torrid Zone*, allowing
only

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only for the Difference of *North* and *South Latitude*. In the *Torrid Zone*, as the *Sun*, by *Day*, is nearly vertical, and raised to the greatest Height above their *Horizon*; so, by *Night*, he is depressed the lowest he can be below their *Horizon*: So that those Places have the least and shortest *Twilight*, and consequently have the least Benefit of the *Sun's Rays* reflected in the *Air*.

In the *Temperate Zones* the *Seasons* are principally ruled by the *Sun's* greater or less Distance from their *Zenith* when on the *Meridian*. Near the *Tropicks*, the *Summer's Heat* is great for the most Part; and in some Places they have the rainy *Seasons*, as in the *Torrid Zone*, where the *Winter* is distinguished from the *Summer*, by rainy and fair *Weather*; but in most Parts of the *Temperate Zones*, we distinguish *Winter* from *Summer* with respect of *Heat* and *Cold*.

In the *Frigid Zones* the *Sun* does not rise above their *Horizon* for several Days, according to the Place's greater or lesser Distance from the *Pole*, and, for an equal Time, does not set. Likewise his Elevation above the *Horizon*, is but very small in those Parts; so that he shines upon them with very oblique *Rays*, and at *Night* he is but depressed a little below their *Horizon*; and in Places near the *polar Circle*, the upper Limb of the *Sun* riseth several Days before his Center Half of the *Sun* takes up the Space of 15° in the Heavens; so that in the *Latitude* of 70°, 75°, &c. the Difference

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Difference of Time, being the Rising of the upper Part and Center, is very small, not above a Day or two : The Declination of the *Sun* in those Parts of the *Ecliptick*, with which he riseth in their *Horizon*, encreaseth quickly : From the small Depression of the *Sun* below the *Horizon*, they enjoy a long *Twilight* of several *Hours*, or *Days*, according to their *Latitude*, which is likewise increased by the *Refraction* of the *Sun's Rays* in the *Air*, which is here much condensed by the *Cold* ; which great *Refraction* makes the *Sun's Body* visible to them, several *Hours*, or *Days*, before he really riseth and sets ; and the *Earth*, in those Parts, is mostly stony, rocky, or hard like Stone, in few Places bituminous, clayey, sulphureous, or fat. Hence, in these Parts is a moderate Fruitfulness ; in those Barrenness, and in these Parts that border on the *Sea*, the *Inland* being yet undiscovered. Some few Parts of the *Frigid Zones* have *Mountains* of a tolerable Height, being mostly stretched out into vast Plains, and the Wind mostly blows from the cold Point, seldom *Easterly*, or *Westerly* ; but in the North *Frigid Zone*, from the *North* ; in the *South*, from the *South* ; and these Parts are much infected with *Fogs* and *Rains*. The Inhabitants of the *Torrid Zone* are called *Ascii*, because the Noon-Sun being sometimes exactly over their Heads, they have no Noon-Shade on either Side of them ; the same are called *Amphiscii*, because the Noon-Shade falls, some Time of the Year, North of them,

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them, some Time *South*. The Inhabitants of the *Temperate Zones* are called *Heteroscii*, having their Noon-Shade only on one Side of them, *North*, or *South*, throughout the whole Year. Such as live in the *Frigid Zones*, are called *Periscii*, because some Time of the Year their Shadow hath a circular Motion in 24 Hours, the Sun not setting to them in that Space of Time, but continuing above their *Horizon*, for 1, 2, &c. or 6 Months together, according as they are farther from, or nearer to, the *Poles*. The *Torrid Zone* contains $46^{\circ} 58'$ Latitude; that is, $23^{\circ} 29'$ on each Side of the *Equator*. Each *Temperate Zone* contains of Latitude $43^{\circ} 21'$, being the Distance between either *Tropick*, and its nearest *polar Circle*: And each *Frigid Zone* is of Breadth $46^{\circ} 58'$; that is, $23^{\circ} 29'$ on each Side of the *Pole*.

The Dimensions of each *Zone* in square *English* Statute Miles (69,5 whereof make a Degree) are as follow, viz. Of the *Torrid Zone* 415474528457; of each *Temperate Zone* 270025710933; of each *Frigid Zone* 43209396510.

So that if the whole Earth were divided into 520 equal Parts, the *Torrid*, both *Temperate*, and both *Frigid Zones*, would bear nearly the following Proportions to one another.

The whole Surface of the <i>Earth</i>	-	520
The <i>Torrid Zone</i>	- - - - -	207
Both <i>Temperate Zones</i>	- - - - -	270
Both <i>Frigid Zones</i>	- - - - -	43
		Def.

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Def. XV. The Earth is divided, in respect of the various Length of Days, into *Climates*. A *Climate* is a Space of the Earth (parallel to the *Equator*) whose longest Day, exceeds the longest Day of the preceding *Climate*, by half an Hour. And whereas the Ancients reckoned but 7 *Climates* on each Side of the *Equator*, viz. to $50^{\circ} 30'$ Latitude, there are now reckoned 30, even up to the *Poles*, according to the following Table: Wherein the Degrees of Latitude shew the Ends of the *Climates* they are set opposite to, and consequently the Beginnings of the *Climates* immediately following: Thus, the first *Climate* beginning at the *Equator*, ends at $8^{\circ} 25'$ Latitude; where the second *Climate* begins, and ends at $16^{\circ} 25'$ Latitude, &c.



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Climates.	Quantity of the longest Day.		Latitude.	
	Hour.	Min.	Deg.	Min.
0	12	00	00	00
1	12	30	08	25
2	13	00	16	25
3	13	30	23	50
4	14	00	20	30
5	14	30	36	28
6	15	00	41	22
7	15	30	45	29
8	16	00	49	01
9	16	30	51	58
10	17	00	54	27
11	17	30	56	37
12	18	00	58	29
13	18	30	59	58
14	19	00	61	18
15	19	30	62	25
16	20	00	63	22
17	20	30	64	06
18	21	00	64	49
19	21	30	65	21
20	22	00	65	47
21	22	30	66	06
22	23	00	66	20
23	23	30	66	28
24	24	00	66	21

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Months	1	2	3	4	5	6
Latitud.	67° 15'	69° 30'	73° 20'	78° 20'	84° 10'	90°

It is apparent, that by the foregoing Table, the Length of the longest Day in any Latitude may be easily found. For Example: *Madrid* being in Latitude $40^{\circ} 10'$, it appears by the Table, that it lies within the sixth Climate, and its longest Day is near 15 Hours: Whereas *Stockholm*, in Latitude $59^{\circ} 33'$, lies within the thirteenth Climate, and its longest Day is near 18 Hours and a half.

The Inhabitants of this Earth are also consider'd with respect to the Position of the *Horizon* with the *Equator*, which is three-fold, viz. either *Right*, cutting it at Right Angles; or it is *Oblique*, or else it is *Parallel*, and does not cut it at all, but coincides with it. Such as have the first of these Positions, are said to inhabit a right Sphere; such as have the second, an oblique; and such as have the third, a parallel Sphere.

Def. XVI. In a right Sphere (namely, where the *Equator* $E Q$, is perpendicular to the *Horizon* $H O$, as in Fig. 2.

The *Equator* will pass through the *Poles* of the *Horizon*, viz. the *Zenith* and *Nadir*, and their *Horizon* passes through the *Poles* of the World $P P$, and every Point in the Heavens will seem to ascend right or perpendicularly above

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above the *Horizon*, because it describes a Circle parallel to the *Equator*, which is right or perpendicular to the *Horizon*. All Places upon the terrestrial *Equator* inhabit a right Sphere. Their *Horizon* bisects the *Equator*, and all its Parallels, as is evident by Figure 2.

Therefore their Days and Nights are always equal ; all the Stars in both Hemispheres are visible at the *Equator*, and those Stars that rise together, come also to the Meridian together, and set all at the same Time, being always as long above as below the *Horizon*.

The Amplitude of the Sun and Stars in a right Sphere, is always equal to their Declination : And the right Ascension, oblique Ascension, and oblique Descension in a right Sphere, is the same.

Def. XVII. In a parallel Sphere, where the *Horizon* H O, (Fig. 3.) coincides with the *Equator* E Q, and the Poles with the *Zenith* and *Nadir*; therefore this Position of the Sphere agrees only with the Inhabitants of the two Poles of the Earth ; and all celestial Bodies, that describe Circles parallel to the *Equator* by their diurnal Motion, will likewise describe Circles parallel to the *Horizon*. It is evident by Fig. 3. that the Sun, during its Declination, from the *Equator* towards that Pole which is in the *Zenith*, is always seen, and makes the Day half a Year long ; as on the contrary, it is half a Year Night, and that

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the Beginning of the Day and Night falls upon the Sun's Ingress into the *Equinoctial* Points; at either *Pole*, the Stars only of one *Hemisphere* are visible at any Time, and those never rise nor set, but constantly describe Circles parallel to the *Horizon*; the other *Hemisphere* of Stars never rise, and therefore not visible to them.

The Altitude of any celestial Phænomenon above the *Horizon* of a parallel Sphere, is always equal to its Declination from the *Equator*; there is no Ascension or Descension in this Sphere, nor any *Meridian*, since it passes through the *Pole* and *Vertex* of the Place; and these two coincide in this Sphere, they cannot determine the Circle, each Vertical having an equal Right to claim the Name of a *Meridian*. Parallels of Declination and Parallels of Altitude, are represented by the same Circles in a parallel Sphere.

Def. XVIII. It is an oblique Sphere, where the *Horizon* H O (Fig. 1.) cuts the *Equator* E Q, at oblique Angles, and therefore one of the *Poles* of the *Equator* is elevated above the *Horizon*, and always visible; and the other below the *Horizon*, and always invisible. There are two kinds of this Sphere, for either the North *Pole* is above the *Horizon*, and the South *Pole* depressed, or the contrary. Those who live between the *Equator* and the *Arctick Pole* have the Sphere of the first kind, and those who live between the *Equator* and
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Fig. 1.

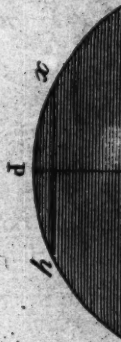
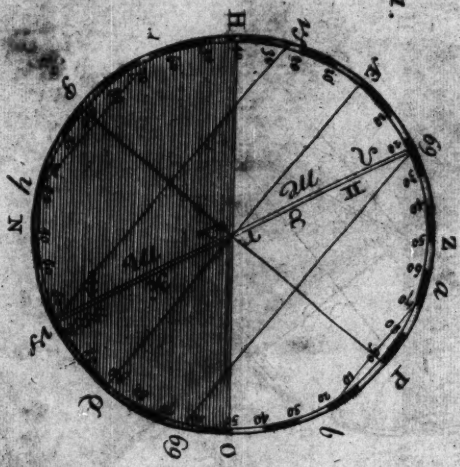


Plate 1st

Fig. 2.

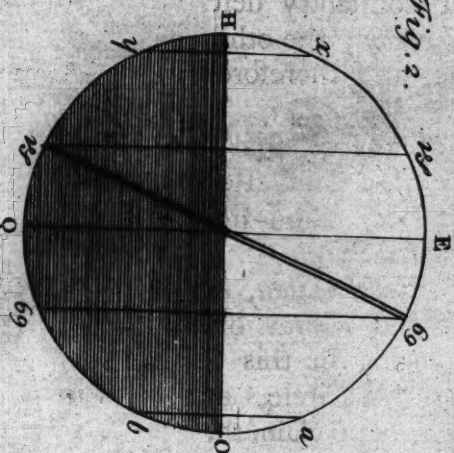
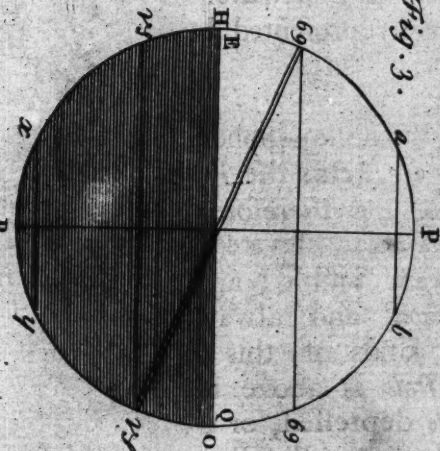


Fig. 3.



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the Antarctick *Pole*, have the latter : Since each Point in the Heavens, by the diurnal Motion, describes the *Equator*, or some of its Parallels ; and only the *Equator*, but not one of its Parallels, is divided into two equal Parts by the *Horizon* of an oblique Sphere. The Sun, and all the Stars that decline towards the visible *Pole*, continue longer above the *Horizon* than below, and on the contrary, such as decline towards the invisible *Pole*, continue hid longer below the *Horizon* than they appear above it ; and this holds to a certain Limit towards both *Poles* ; for if the Distance of a Star, or celestial Phænomenon, from the visible *Pole*, be less than the Elevation of the *Pole* above the *Horizon*, the Star or Phænomenon does not set at all ; but if its Distance from the invisible *Pole*, be less, it will not rise at all.

All these Phænomena may be explained from the preceding Diagrams ; for it is evident, that in Fig. 2. the *Equator*, and all its Parallels are perpendicular to, and equally divided by the *Horizon* ; one half of those Parallels being above, and the other below it. In Fig. 3. the *Equator* coincides with the *Horizon*, and all the Parallels on the North Side of it, are above the *Horizon*. And in Fig. 1. all the Parallels to the *Equator* are unequally divided by the *Horizon*, which shews the Variety of the unequal Days and Nights in an oblique Sphere,

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Supposing Parallels of Latitude to be drawn through every Degree and Minute of the *Meridian*, which we shall call *simply Parallels*; and calling the two opposite *Semicircles of the same Meridian*, as they are cut off by the *Axis* of the World, *Opposite Meridians*, then we may divide the Inhabitants of the Earth into *Antæci*, *Periæci*, and *Antipodes*.

Def. XIX. Antæci have the same Meridian, but opposite Parallels; they have Noon and Midnight at the same Time, but opposite Seasons and opposite Poles elevated.

Def. XX. Periæci have the same Parallels but opposite Meridians; they have the same Seasons and the same Pole elevated, but opposite Days and Nights.

Def. XXI. Antipodes have opposite Meridians and opposite Parallels, they being diametrically opposite to one another; they have opposite Seasons, opposite Days and Nights, and opposite Poles elevated.

Having taken a View of the chief Circles belonging to the *Terraqueous* Globe, as also the manner how Latitude and Longitude with *Zones* and *Climates* are numbred; we proceed next to view its Surface, as composed of Land and Water, as to its sole constituent Parts; and those two Parts thus subdivided, as follow, *viz.*

Land

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<i>Land into</i>	<i>Water into</i>
Continents,	Oceans,
Isthmus's,	Streights,
Islands,	Seas,
Promontories,	Lakes,
Peninsula's,	Gulfs,
Mountains.	Rivers.

Def. XXII. A *Continent* is a large continued Space of Land, containing many Countries and Kingdoms; and consequently not easily discernible to be surrounded with the Sea. It is also called, *The Main*, or *Firm Land*.

Def. XXIII. An *Island* is a smaller Tract of Land, which more plainly appears to lie in the Sea.

Def. XXIV. A *Peninsula* is a Part of Land, which is almost an *Island*, being encompassed with the Sea; but where it is joined to the *Continent* by some narrow Neck of Land, which narrow Neck is called an *Isthmus*.

Def. XXV. A *Promontory*, or *Cape*, is a Mountain, or some considerable Eminence shooting out into the Sea. If the Land shooting out, be level, or hath no considerable Rising, it is called a *Point*.

All the vast Assemblage, or Body of salt Water in general, is call'd *Sea*, which Name

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is also promiscuously apply'd to any of its following Parts.

Def. XXVI. The *Ocean* is the wide open Part of the Sea, lying without the Land.

Def. XXVII. A *Gulf* is an Arm or Branch of the *Sea*, received, as it were, into the Bosom of the Earth. Lesser *Gulfs* are term'd *Creeks*, *Bays*, and *Roads*.

Def. XXVIII. A *Streight* is a narrow Part of the Sea, pent up, for the most Part, between two Promontories, and joyning some *Gulf* to the *Ocean*, or two Seas to one another.

Def. XXIX. A *Lake* is a great Collection of Water, which hath no Communication with the Sea, but by some *River*, or subterraneous Passages. A *Morass* differs from a *Lake*, in that it is not always full of Water, or at least may be drain'd.

As for *Rocks*, *Hills*, *Mountains*, *Valleys*, &c. as also (the Terms of fresh Water) *Rivers*, *Brooks*, *Springs*, &c. they need no Explanation.





S E C T. II.

Of the General Divisions of the Terraqueous Globe.

THE *Terraqueous* Globe is made up of two general Parts, the *Earth* and *Sea*, I shall begin with a Description of the latter, as encompassing the former.

It was distinguished by the *Ancients* into the *Northern*, *Southern*, *Eastern* and *Western Oceans*; and although the same Distinction might still serve, yet another *Continent*, besides that anciently known, having been since discovered, which is so situated, that the old *Western Ocean* is its *Eastern*, and on the contrary; it seems more commodious to call the Sea lying between the *Western* Coast of the old Continent and the *Eastern* Coast of the new Continent, by the Name of the *Atlantick Ocean*, the same being taken from the famous Mount *Atlas* on the *Western* Shore of *Africk*; and in like manner to call the Sea, lying between the *Eastern* Coast of the old Continent, and the *Western* Coast of the new Continent, by the Name of the *Pacifick Ocean* (in respect of the great Tranquillity generally observed by

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by Seamen, and the Freedom from Tempests of any kind, in a great Part of it, particularly on the Coast of *Peru*) or of the *Indian Ocean*, for as much as it lies between the *East* and *West Indies*.

The *Northern* and *Southern Oceans* retain their Names from their Situation, with respect to the *Poles*.

Each *Ocean*, or *General Sea* (as formerly, so now) is distinguished into lesser Seas or *Gulfs*, &c. by several Denominations (taken for the most part) from Countries lying adjacent to them. The chief of the inland Seas are, *viz.*

The *Baltick Sea*, bounded with *Sweden* on the *West*, and *Poland* and *Germany* on the *East* and *South*.

The *German Sea*, enclosed with *Scandinavia* on the *East*, and *Great Britain* on the *West*.

The *Irish Sea*, lying between *Ireland* and *England*.

The *Mediterranean Sea*, bounded by *Europe* on the *North*, and *Africa* on the *South*.

The *Euxine Sea*, enclosed with Part of *Europe* on the *North* and *West*, and Part of *Asia* on the *South*.

The *Caspian Sea* lying in *Asia*.

The *Earth*, the other Part of the *Terraqueous* Globe, may be divided into four Parts, two whereof are known, the one anciently lying *Eastward* in respect of our *Hemisphere*, call'd therefore the *Eastern*, or *old Continent* ;
the

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the other lately discover'd, lying *Westward*, and from thence call'd the *Western*, or *new Continent*; the two remaining Parts being but little discovered, are said to be *unknown*, and from their particular Situations, the one is call'd the *Northern*, and the other the *Southern unknown Continent*.

I shall first treat of the *Eastern*, or *old Continent*; the Division whereof into three Parts, viz. *Europe*, *Asia*, and *Africa*, has been generally received; it being, in all probability, made as soon as the Ancients came to have a compleat Knowledge of the Course of the *Mediterranean* and *Red Seas*, by the Interflux of which two, Nature hath given sufficient Directions for such a Tripartition.

And here it may not be unuseful to observe, that whereas, *Europe*, *Asia*, and *Africa*, may now-a-days most properly be look'd upon as making one *Continent*, the Ancients esteem'd them as three distinct *Continents*, giving to all three considered together, the Name of *World*; forasmuch as all they knew of the *World* comprehended no more than what they knew of these three, which was much less than what now goes under the same Name, and scarce a fourth Part of what is at present known of the whole *World*.

And thus much for the general Divisions of the *Terraqueous Globe*, as also of the *old Continent*. I now proceed to a more particular Description of the *Globe*, as divided into *Europe*, *Asia*, *Africa*, and *America*.

SECT.



S E C T. III.

Of the Divisions of EUROPE.

EUROPE is bounded to the Northward by the Northern Ocean; Westward, partly by the Northern, and partly by the Atlantick Oceans; Southward, by the Streights of Gibraltar and the Mediterranean Sea, by which it is parted from Africa; and on the East, it is parted by the Archipelago, or Ægean Sea, Streights of the Dardanel, Sea of Marmora or Propontis, Streights of Constantinople, Black Sea or Pontus Euxinus, Streights of Caffa, Sea of Zaback or the Palus Mæotis, the River Don or Tanais.



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The *European* Continent is divided into

Portugal,	} Chief Towns	<i>Lisbon.</i>
Spain,		<i>Madrid.</i>
Italy,		<i>Rome.</i>
Turkey,		<i>Constantinople.</i>
France,		<i>Paris.</i>
Germany,		<i>Vienna.</i>
Poland,		{ <i>Cracow, and</i>
		{ <i>Warsaw.</i>
Hungary,		<i>Buda.</i>
Switzerland,		{ <i>Basil, and</i>
		{ <i>Geneva.</i>
Little Tartary,		<i>Cassa.</i>
Nether- { United,		<i>Amsterdam.</i>
lands { Spanish,		<i>Brussels.</i>
Muscovy,		<i>Muscow.</i>
Sweden,		<i>Stockholm.</i>
Denmark,		<i>Copenhagen.</i>
Norway,		<i>Bergen.</i>

The chief of the *European* Islands are

Great- { England,	} Chief Towns	<i>London.</i>
Britain { Scotland,		<i>Edinburgh.</i>
Ireland,		<i>Dublin.</i>
Iceland,		<i>Shalholt.</i>
Sicily,		<i>Palermo.</i>
Sardinia,		<i>Cagliari.</i>
Corfica,		<i>Bastia.</i>
Candie,		<i>Candia.</i>

These

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These being the general Divisions of *Europe*, let us next proceed to consider how each of them is bounded and subdivided.

Of PORTUGAL.

IT is bounded on the *North* and *East* with *Spain*, on the *West* with the *Western Ocean*.

It is from the Frontiers of *Galicia*, North, to the furthestmost Point of *Algarve*, South, about 300 *Italian* Miles long. And from the Frontiers of *Estremadura* East, to the *Ocean* West, 130 broad.

This Country is much of the Nature of *Spain*, of which it was anciently a Province: generally *mountainous* and dry, unfit for Corn or Pasture. But by favour of the Sea, of a more temperate Air than many other Parts in *Spain*, which lie in the same Parallel; and abounding with good Fruit and Wines, and water'd with good Rivers, it is not unpleasant.

The chief Rivers of *Portugal* are, the *Tagus*, the *Douro*, and the *Guadiana*.

The chief Divisions of *Portugal* are

Entre Minho-Douro,	Chief Towns	<i>Braga.</i>
Tralos Montes,		<i>Miranda.</i>
Beira,		<i>Coimbra.</i>
Estremadura,		<i>Lisbon.</i>
Alen Tajo,		<i>Evora.</i>
Algarve,		<i>Tavira.</i>

Of

Of SPAIN.

IT is situated between the 9th and 22d Degree of *Longitude*, and between the 35°, 30'. and 44° of North *Latitude*.

It is bounded on the North with *France* and the *Bay of Biscay*; on the South with the *Mediterranean* and the *Streights*, and on the West with the *Ocean* and *Portugal*.

It is about 750 *Italian Miles* long, viz. from *France* to *Cape St. Vincent* N. E. and S. W. and about 510 broad, viz. from *Cape Palos* S. E. to *Cape Finister* N. W.

The Character of *Spain*, like the Country, is very unequal, it being, in many Parts, a very mountainous hilly Country, very hot in *Summer*, and very sharp in *Winter*; and, except towards the Sea Coasts, of a very barren Soil, over-run with Woods and Rocks, or buried in Sand; and abounding in others with great Variety of *Fruits*, and rich *Wines*, and well water'd with good *Rivers*: But in general, it is esteem'd one of the Favourites of Nature, in this part of the Globe. And the rich *Mines* which it is Master of in the *West-Indies*, makes it the Favourite of Princes too, and the frequent Contest of their Arms.

The chief Rivers are, the *Tagus*, the *Erbe*, the *Douro*, the *Guadiana*, the *Guadalquiver*, the *Minho*.

The chief Mountains are, the *Pyreneans*, the *Scerra Morina*, the *Scerra Nevada*.

Spain

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Spain is divided into thirteen great Parts or *Provinces*, which are divided again into above sixty more.

The chief Divisions are,

Biscay,	} Chief Towns	Bilboa.
Asturia,		Oviedo.
Gallicia,		Compostella.
Andaloufia,		Seville.
Granada,		Granada.
Murcia,		Murcia.
Valencia,		Valencia.
Catalonia,		Barcelona.
Arragon,		Saragosa.
Navarre,		Pampeluna.
Old Castile,		Burgos.
Leon,		Leon.
New Castile,		Madrid.

Of ITALY.

IT is situated between 26 and 38 Degrees of *Longitude*, and between 38° and 46° of *North Latitude*.

It is bounded on the North with *Switzerland*, *Germany*, and the *Adriatick*; on the South with the *Mediterranean*; on the East with the *Adriatick*, and on the West with *France*.

It is about 760 *Italian Miles* in Length, from *Geneva* North West, to the Cape of *Naples* South East. The Breadth is from *Trieſte* on the Frontiers of *Germany*, North East, to
Nico

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Nice on the Frontiers of *Dauphine*, South West.

The *Geographers* generally agree, that this is the finest Country in *Europe*. For being happily situated almost in the Middle of the Globe, it receives such a gracious Influence of the *Sun*, and enjoys such a perpetual *Spring*, that it is of the richest Soil, for the best Corn, *Wines*, Fruits, &c. of the purest *Air*, in many Parts, and in general, the finest *Landskip* of *Ever-Greens*, blooming or bearing Fruits, or *Vines*, in *Europe*: Well water'd, with good *Rivers* in the Vales; and in the Mountains with which in many Parts it is cover'd, well furnished with rich Quarries of Marble, and other valuable *Mines*; and from hence is usually call'd, by the *Geographers*, the *Garden of Europe*. But as no Country has the *Vote* of the *Universe*, some object the Heats are too violent, and others, that it is too great a *Favourite* of *Nature*, and, like the eldest Sister, runs away with too great a Portion of her Blessing from the rest of the World.

The chief *Rivers* of *Italy* are thirteen, viz. The *Adige*, the *Minco*, the *Oglio*, the *Volturmo*, the *Ticino*, the *Sessia*, the *Doria Major* and *Minor*, the *Po*, the *Secchia*, the *Rubicon*, the *Arnus*, the *Cariglia*, and the *Tiber*.

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The Lakes are,

Garda,	} Chief Places	Garda.
Coma,		Coma.
Maggiore,		Sesto.
Iseo,		Iseo.
Lugano,		Lugano.
Geneva,		Geneva.

The chief Mountains are the *Alps*, which lie between *France*, *Germany*, and *Italy*; and *Appenine*, running along the Middle of *Italy*.

Italy is divided into Twelve great Parts, which are divided again into above a hundred.

Savoy, <i>Dukedom</i>	} Chief Towns	Chambery.
Piedmont, <i>Princip.</i>		Turin.
Monferrat, <i>Duked.</i>		Casal.
Parma, D ^o		Parma.
Modena, D ^o		Modena.
Mantua, D ^o		Mantua.
Milan, D ^o		Milan.
Venice, <i>Republick</i>		Venice.
Tuscany, <i>Duked.</i>		Florence.
Genoa, <i>Republick</i>		Genoa.
Land of the Church		Rome.
Naples, <i>Kingdom</i>		Naples.



Of TURKEY in EUROPE.

IT is bounded by *Muscovy* and *Poland* on the North, by the *Mediterranean* on the South, by *Asia* on the East, and by the *Adriatick* and *Germany* on the West.

It lies between the 36 and 53 Degrees of *Longitude*, and between the 36 Deg. 30 Min. and 49 Deg. 20 Min. of *Latitude*. It is about 770 Miles in Length, and 660 in Breadth, and is at present divided into two Parts, *North* of the *Danube*, and *South* of the *Danube*.

North comprehends,

Transilvania,	} Chief	{	<i>Hermanstat.</i>
Valachia,			<i>Tergowick.</i>
Moldavia,			<i>Saczow.</i>
Little Tartary,			<i>Crim.</i>

South comprehends,

Romania,	} Chief	{	<i>Constantinople.</i>
Bulgaria,			<i>Sophia.</i>
Servia,			<i>Belgrade.</i>
Bosnia,			<i>Bosna Seraio.</i>
Sclavonia,			<i>Possaga.</i>
Croatia,			<i>Wibitz.</i>
Dalmatia,			<i>Spalatro.</i>
Greece,			<i>Saloniki.</i>

There are ten Provinces which lie between *Hungary* and *Greece*, and are called, the *Danubian* Provinces; they are bounded on the

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North with *Hungary* and *Poland*, on the South with *Greece* and the *Archipelago*, on the East with the *Black Sea*, on the West with *Germany* and the *Adriatick*; the Names of which are as follow ;

Transilvania,
Valachia,
Moldavia,
Romania,
Servia,
Bosnia,
Sclavonia,
Croatia,
Dalmatia,
Bulgaria,

Chief
Towns

Hermanstadt.
Tergowick.
Saczow.
Constantinople.
Belgrade.
Bosnia Servis.
Possëga.
Wibatz.
Spalatro.
Sophia.

They are, for the most Part, mountainous and barren Countries, except *Romania*, which produceth good Corn and Wine. The Rivers the same as in *Hungary*.

Of G R E E C E.

IT is bounded on the North with the *Danubian* Provinces, on the South with the *Mediterranean*, on the East with the *Archipelago*, and on the West with the *Ionian Sea* ; it is about 470 *Italian* Miles long, and 340 broad.

Greece is much of the Nature of the *Danubian* Provinces, a mix'd Country of Mountain

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tain and Champaign, but more famous for both, among the ancient Poets : It is of a rich Soil for Corn, Fruits, and Pasture, and is of a very wholesome Air, and inhabited by a People, anciently, the most eminent in the World, for their Arms and Arts : It is now divided into six Provinces ;

Macedonia,	} Chief Towns	<i>Salonichi.</i>
Albania,		<i>Sintari.</i>
Theffalia,		<i>Larisse.</i>
Epirus,		<i>Canina.</i>
Achaia,		<i>Lepanta.</i>
Morea,		<i>Mistira.</i>

Of FRANCE.

IT is situated between the 12 and 29 Deg. of *Longitude*, and between the 42 and 51 of North *Latitude*.

It is bounded on the North with the *Ocean*, the *Channel*, and *Low Countries* ; on the South with *Spain* and the *Mediterranean*, on the East with *Italy* and *Germany*, and on the West with the great *Western Ocean*.

It is about 550 *Italian Miles* long, from *Dunkirk*, North, to the furthest Part of *Roussillon*, on the Frontiers of *Spain*, South : And its Breadth from *Toulon*, on the Coast of the *Mediterranean*, South East, to the *Channel* near *Bayon*, North West, is about 450 Miles.

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Its Character is, as it lies next the Garden of *Europe*, there are some (besides the Natives) who stick not to make this Country Rival with it. The Landskip is so fine, of *Corn, Wines, Fruits, &c.* that no covetous or curious Eye, in *Heylin's* Opinion, ever had a fairer Prospect to feed upon ; and its Situation so happy, in the Middle of the temperate Zone, that, for a healthful Country *Falconer* prefers it ; and, as its Enemies own, the Plenty and Power, Industry and Ingenuity of its Inhabitants have been so great, that they have more than once unwillingly styl'd it, *Le plus grand Royaume du' Mond.* But without Partiality or Hyperbole, it must be own'd, if not the Rival, at least the second to the finest Country of *Europe* (*Italy*).

The chief Rivers are ten, viz. the *Rhine*, the *Saone*, the *Rhosne*, the *Seyn*, the *Loyre*, the *Moselle*, the *Charente*, the *Garonne*, the *Adour*, the *Derdonne*.

The chief Mountains are the *Pyreneans*, and the Mountains in *Languedoc* and *Dauphine*.

France is divided into twelve Governments, besides the Conquests, viz.

Picardy

Picardy,	} Chief Towns	<i>Amiens.</i>
Champaign,		<i>Troyes.</i>
Ile of France,		<i>Paris.</i>
Normandy,		<i>Rouen.</i>
Britany,		<i>Rennes.</i>
Orleans,		<i>Orleans.</i>
Burgundy,		<i>Dijon.</i>
Lionois,		<i>Lyons.</i>
Languedoc,		<i>Toulouse.</i>
Dauphine,		<i>Grenoble.</i>
Provence,		<i>Aix.</i>
Guienne,		<i>Bourdeaux.</i>

Of GERMANY.

IT is situated between the 24 and 37 Deg. of *Longitude*, and between the 45 and 54 Deg. of North *Latitude*.

It is bounded on the North with *Denmark*, the *Baltick*, and *German Sea*; on the South with the *Swiss*, *Grisons*, *Trent*, part of the *Adriatick*, and part of *Turkey*; on the East with *Hungary* and *Poland*; and on the West with *Holland* and *Flanders*.

The Length of it is about 640 *Italian Miles*, from the furthestmost Part of *Pomerania*, North, to the Frontiers of *Trent*, South.

Its Breadth about 550 *Italian Miles*, and for the most Part, carries a great Breadth, from the Frontiers of *Poland* in *Silesia*, East, to the Frontiers of *France* in the Bishoprick of *Treves*, West.

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This Country, as Mr. Gordon in his *Geographical Grammar* observes well, consists of great *Variety*; in the North Parts being cold, and over-run with *Woods* and *Mountains*, and in the South, upon the *Rhine* especially, being of a warm Climate and good Soil; but in the main, as the same Author observes, it is a *tolerable pleasant, profitable, healthful Country*, recompensing in good *Pasture* in some Parts, the want of *Corn, Fruits, Wines, &c.* which it is supply'd with from others; and, which adds to it, inhabited by a People so famous for *Honesty* and *Sincerity*, that some are of Opinion that they receiv'd thence the Name of *Germans*.

The chief Rivers are eleven, *viz.* The *Danube*, the *Drave*, the *Save*, the *Oder*, the *Elbe*, the *Rhine*, the *Moselle*, the *Meuse*, the *Mein*, the *Necar*, the *Weser*.

It is divided into twelve Circles, *viz.*

Belgium,	} Chief Towns	} are {	<i>Amsterdam.</i>
Westphalia,			<i>Brussels.</i>
Lower Saxony,			<i>Munster.</i>
Higher Saxony,			<i>Hamburg.</i>
Lower Rhine,			<i>Wettenberg.</i>
Higher Rhine,			<i>Heidelberg.</i>
Franconia,			<i>Francfort.</i>
Suabia,			<i>Nuremburg.</i>
Bavaria,			<i>Ausburg.</i>
Austria,			<i>Munich.</i>
			<i>Vienna.</i>

Of

Of *P O L A N D.*

IT is situated between the 34 and 53 Deg. of *Longitude*, and between 48 and 57 Deg. of North *Latitude*.

It is bounded on the North with *Muscovy*, *Livonia*, and the *Baltick*; on the South with *Hungary*, *Transilvania*, and *Turkey*; on the East with *Little Tartary* and *Muscovy*; and on the West with the *Baltick* and *Germany*.

It is about 780 *Italian Miles* long, from *Zantock* on the Frontiers of *Brandenburg*, North West, to the furthestmost Point of *Ukrania*, near the Mouth of the *Nieper*, South East; and Breadth 590, from the furthest Point of *Courland* on the *Baltick*, North, to the furthest Point of the Palatinate of *Lemberg*, on the Frontiers of *Transilvania*, South.

This Country, with Geographers, bears generally the Name of a good Country, for the most Part champaign, and inclining more to *marshy* than *mountainous* Land, except on the Side of *Hungary*: In most Parts of a good Air, except *Lithuania*, and of a Soil so rich for *Corn*, that it is styl'd by some, *the Granary of the North*. It is also well stock'd with good *Rivers*, and in some Places with good *Mines* of *Lead*, *Silver*, &c. and is inhabited by a stout, honest, generous sort of People, but very unhappy in its Constitution.

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The chief Rivers are six, *viz.* The *Nieper* or *Borissbenes*, the *Nister*, the *Dwina*, the *Niemen*, the *Vistula*, and the *Warta*.

The chief Lakes are three, the *Reibus*, the *Briale*, and the *Goldo*.

The chief Mountains are the *Caparthians*.

It is divided into thirty Parts, the chief of which are ten, *viz.*

Volhinia,	} Chief Towns	<i>Kiow.</i>
Podolia,		<i>Camienieck.</i>
Little Russia,		<i>Lemberg.</i>
Podlaquia,		<i>Beitzko.</i>
Samogitia,		<i>Rosinie.</i>
Curland,		<i>Mittau.</i>
Prussia,		<i>Dantzick.</i>
Warsovia,		<i>Warsaw.</i>
Polonia,		<i>Cracow.</i>
Lithuania,		<i>Vilna.</i>

Of HUNGARY.

IT is situated between the 40 and 47 Deg. of *Longitude*, and between the 43 and 49 Deg. 10 Min. of North *Latitude*.

It is bounded on the North with *Poland*, and on the South with the *Danubian* Provinces, on the East with *Transylvania*, and on the West with *Austria*, *Moravia*, &c.

It is about 420 *Italian* Miles long, from the Frontiers of *Transylvania*, East, to the Frontiers of *Stiria*, West; and 290 Miles broad, from

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from the Frontiers of *Poland*, North, to the River *Drave*, South.

This Country has the Character of a very beautiful rich Country : The Frontiers, for the most part, *mountainous*, and the inland Parts, for the most part, *champaign*, make a very agreeable *Landskip* ; and the Soil is so rich and fertil for *Corn*, *Fruit*, *Wine*, *Pasture*, &c. that it hardly yields to any Part of the World : It is also so rich in *Gold*, *Silver*, *Tin*, *Copper*, &c. *Mines*, that no less than seven Towns are call'd the *Mine Towns* ; and no Country has better *Rivers*, nor more Plenty, for Transportation and Trade : But withal, being full of Morasses, the Air, for the most part, being unwholsome, and joyning upon *Turkey*, and inhabited by a People of a turbulent and rebellious Disposition, is but an unpleasant Country to live in.

The chief Rivers are *Tyess*, the *Raab*, the *Drave*, the *Gran*, the *Waag*, and the *Danube*.

The chief Lakes, the *Balaton*, new *Fidler Sea*.

It is divided into *Upper* and *Lower Hungary* ; the *Upper* is about 338 *Italian Miles* long, and 160 broad ; *Lower Hungary* is 360 long, and about 290 broad.



Of *SWISSERLAND*.

IT is situated between the 28 and 32 Deg. 40 Min. of *Longitude*, and between the 40° 40' and 47° 40' North *Latitude*.

It is bounded on the North with *Suabia*, on the South with *Savoy*, the *Milaneze*, and the State of *Venice*, on the East with *Tirol*, and the State of *Venice*, and on the West with *Burgundy* and *Dauphine*.

It is about 206 *Italian Miles* long, from the Frontiers of *Tirol* about *Samun*, East, to the Frontiers of *Burgundy* about *Chateau Villau*, West, and about 130 broad, from about *Fesseu* on the Frontiers of *Suabia*, North, to the Frontiers of *Milan* about *Brisago*, South.

This Country, as it is in Neighbourhood so is it in Nature, very near to *Germany*, for the most part very *mountainous* and *barren*, except in the Vales, which produce some *Corn* and *Wine*, but not sufficient for their *Necessities*; and by Reason of their unhappy *Situation*, though well provided with *Rivers*, cannot repair by Trade what they want at home, there being none *navigable*. But, in amends, it is generally famous for Plenty of good *Soldiers* and honest *Men*, which has recommended them to most *Courts* in *Europe*, particularly *France* and *Britain*.

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The Rivers are, the *Aar*, the *Rhine*, the *Rhofne*.

The Lakes are, *viz.*

Neufchatel,	} Chief Places	{ <i>Pyverden.</i>
Lucern,		{ <i>Lucern.</i>
Zurich,		{ <i>Zurich.</i>
Zug,		{ <i>Zug.</i>

Swisserland is divided into three great Parts, *viz.* The *Cantons*, the *Grisons*, and *Prefe-ctures*.

There are thirteen *Swifs* Cantons, *viz.*

Zurich,	} Chief Towns	{ The fame with the Cantons.
Bern,		
Bafil,		
Lucern,		
Soleure,		
Friburg,		
Scafhaufen,		
Switz,		
Zug,		
Appenzel,		
Glaris,	except <i>Stantz.</i>	
Underwalde,		
Uri,		



Of

OF FLANDERS.

IT is situated between 23 Deg. 10 Min. and the 28 of *Longitude*, and between the 50 30 and the 51 and 30 of North *Latitude*.

It is bounded on the North with *Holland* and the *German Sea*, on the South with *France*, on the East with the *Palatinate*, and on the West with the Sea of *Calais*.

It is about 212 *Italian Miles* long, from *Graveling*, North West, to the furthest Part of *Luxemburg*, South East; and about 110 broad, from the Frontiers of the *Dutch Brabant*, North, to the Frontiers of *Lorrain*, South.

It is, in general, a fine even Country, neither Wood-Land nor Champaign, but agreeably mix'd with both: Of a good healthful Air, a rich Soil for *Corn*, *Fruit*, *Pasture*, *Wine*, &c. well provided with good Rivers and Canals, and in some Parts with good Mines of Coal, Lead, Iron, Marble, &c. and in short, as it is usually said of it, able in four Years Peace to recover seven Years War.

The chief Rivers are, the *Maes*, the *Sambre*, the *Demer*, the *Dyle*, the *Senne*, the *Lys*, the *Scheld*, the *Tenre*, the *Yser*, the *Colm*, and the *Aa*.

It is divided into ten Provinces, *viz.*

Flanders,	} Chief Towns	<i>Bruges.</i>
Artois,		<i>Arras.</i>
Hainault,		<i>Mons.</i>
Namur,		<i>Namur.</i>
Brabant,		<i>Brussels.</i>
Limburg,		<i>Limburg.</i>
Leige,		<i>Leige.</i>
Luxemburg,		<i>Luxemburg.</i>
Mecklin,		<i>Mecklin.</i>
Antwerp,		<i>Antwerp.</i>

Of HOLLAND.

IT is situated between the 24 30 and the 28 30 *Longitude*, and between the 51 30 and the 53 45 of North *Latitude*.

It is bounded on the North with the *North Sea*, on the South with *Brabant* and *Flanders*, on the East with *Westphalia*, and on the West with the *German Sea*.

It is about 180 *Italian Miles* long, from the Borders of *Groninghen*, North East, to *Antwerp* in *Brabant*, South West; and 117 Miles broad, from the furthest Part of *Zutphen* near *Grol*, East, to the Sea Coast near the *Hague*, West.

If the Nature of *Holland* only be consider'd, it may be justly said, a very bad Country: For, except the West Coast of *Holland* and *West-Friesland*, which is mountainous, it is generally a very low fenny Country, full
of

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of small Rivers and Dykes, especially in *Holland* and *Utrecht*. from which may be guess'd the Nature of the Soil, and Air, yet by Favour of Trade, it is so plentiful a Country of all Things, that, as Mr. Gordon says, in his *Grammar*, it may be reckon'd the Warehouse of the richest and best Commodities of all Nations.

They have five Rivers, *viz.* The *Rhine*, the *Maes*, the *Weser*, the *Ysel*, the *Velch*.

One Lake, *viz.* The *Harlem-Meer*, which is eighteen *Italian* Miles long, and six broad.

It is divided into seven Provinces, *viz.*

Groningen,	} Chief Towns	Groningen.
Friesland,		Lewarden.
Over-Iffel,		Deventer.
Gelderland,		Gelders.
Utrecht,		Utrecht.
Zealand,		Middleburg.
Holland,		Amsterdam.

Of MUSCOVY.

IT is situated between the 46 and 110 Deg. of *Longitude*, and between the 45 and 72 Deg. of North *Latitude*.

It is bounded on the North with the *Northern Ocean*, on the South with *Little Tartary*, *Georgia*, and the *Caspian* Sea; on the East with *Tartary*; and on the West with *Poland* and *Swedeland*.

It

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It is about 1360 *Italian Miles* long, from the South Parts of *Asiracan*, on the Frontiers of *Asia*, to the Mouth of *Oby*, North; and about 1230 broad, from the Frontiers of *Poland*, South West, to the River *Oby*, North East.

This vast Country, as Authors observe, bears many different Characters, but scarce in any, a good one: On the North and South East Side over-run with Mountains; on the rest, for the most part, with Woods and Morasses; on the North all Wilderness, and cold to Excess; on the South fertil, and hot to Excess; in both unwholsome and unpleasant, and, which adds to the Unhappiness of it, generally inhabited by a People degenerate (for want of Learning and Instruction, but of late much improved in both) into all the Corruptions of Nature; but by the Favour of good Rivers, with which it abounds, it has a vast Trade with *Persia* and the Eastern Countries; and, by Sea, with *Europe*, which brings it in vast Revenues.

The Rivers are, the *Oby*, the *Kama*, the *Volga*, the *Tanais*, the *Dwina*, the *Nuper*.

The Lakes are, the *Belesewro* and the *Ilmen*.

The chief Mountains are, the *Rapbean* on the Borders of *Asia*, and *Mareghar* on the Frontiers of *Tartary*, and the *Hyperborean* Mount.

Muscovy is divided into 37 Provinces, the chief of which are 14, viz.

E

First,

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First, in the *North.*

Triens,	} Chief Towns	<i>Triens.</i>
Kargapol,		<i>Kargapol.</i>
Dwina,		<i>S. M. Archangel.</i>
Condora,		<i>Wingatouria.</i>
Siberia,		<i>Tobol.</i>
Obdora,		<i>Berezow.</i>
Vologda,		<i>Vologda.</i>

Secondly, in the *South.*

Mordowitz,	} Chief Towns	<i>Casan.</i>
Casan,		<i>Kisfinovogrod.</i>
Kisfinovogrod,		<i>Volodimir.</i>
Volodimir,		<i>Moscow.</i>
Moscow,		<i>Astracan.</i>
Astracan,		<i>Novogorodweliki.</i>
Novogorodweliki,		<i>Pleskow.</i>
Pleskow,		<i>Novogrod-Sewaski.</i>
Severia,		

Of S W E D E N.

IT is situated between the 32 Deg. 30 Min. and the 50 Deg. 30 Min. of *Longitude*, and between the 55 Deg. 51' and the 68 Deg. 52 Min. North *Latitude*.

It is bounded on the North with *Lapland*, on the South with the *Baltick* and Part of *Muscovy*, on the East with *Muscovy*, and on the West with the *Dofrine Hills* that part it from *Norway*. It is about 900 *Italian Miles* long, and 810 broad; the chief Place is *Stockholm*.

This

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This Country, as well as the two following, is a very mountainous, barren, cold Country, full of Woods, Rocks, Lakes, Gulfs, &c. except in the South Parts, which are said to be of a very temperate Air, and abundantly fruitful: But it has, of old Time, been so fertile of People, that it sent vast Numbers into foreign Parts, so that, as Mr. Gordon in his *Geographical Grammar* observes, it may be justly styl'd, the *Store-house of Nations*.

Chief Lakes are,

D'Onega,
Ladoga,
Wener,
Weter,

}	Chief Towns	Osero.
		Notsberg.
		Carolstadt.
		Ealkoping.

Swedish Isles are,

Oceland,
Gothland,
Dagho,
Oefal,
Aland,
Bornholm,

}	Chief Towns	Borkholm.
		Arenberg.
		Padan.
		Arensberg.
		Castelholm.
		Nex.

Of DENMARK.

IT is a Peninsula, and is a Promontory on the North Part of Germany, which runs out between the *Baltick* and the *German Sea*, and is situated between the 3 and 33 Deg.

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of *Longitude*, and between the 54 Deg. 10 Min. and 58 Deg. of North *Latitude*.

It is bounded on the North and East with the *Baltick*, on the South with *Germany*, and on the West with the *German Sea*; it is about 180 *Italian Miles* long, and about 100 broad in North *Futland*, but in some Parts it is not above 30 over.

The chief Lakes are, *Vennoe*, *Silenter*, and *Wisten*.

Chief Islands belonging to Denmark.

Seeland.

Funen,
Langland,
Laland,
Falster,
Mona,
Femerren,
Alsen,

Chief
Places

Copenhagen, chief
City of the *Danes*.
Odenfee.
Ruthkoping.
Narkow.
Nikoping.
Steg.
Berg.
Sonderberg.

Of NORWAY.

IT is situated between 58 Deg. 30 Min. and 72 Deg. of North *Latitude*, and between the 25 and 45 Deg. of *Longitude*.

It is about 1000 *Italian Miles* long, and 240 broad. It is bounded on the North with the *North Frozen Ocean*, on the South with the *Baltick*, on the East with *Sweden*, and on the West with the *German Sea*. The chief City is *Bergen*.

Islands

Islands belonging to Norway.

Carmen,	}	Chief Places	_____
Kilteren,			_____
Sanien,			_____
Suroy,			_____
Groenland,			<i>Bearford.</i>
Friezland,			_____
Iceland,			<i>Shalbolt.</i>

OF GREAT-BRITAIN.

Great-Britain is situated between the 14 and 22 Deg. 30 Min. of *Longitude*, and between the 50 Deg. 30 Min. and 59 Deg. of *North Latitude*.

Great-Britain is divided into three Parts, viz. *England*, *Wales*, and *Scotland*, of which in their proper Order.

OF ENGLAND.

England is from North to South about 320 Miles, and from East to West about 290 Miles, and is, in general, a fine Country, being mountainous on the Outside, but within-land generally level, champaign, and well watered, abounding with Corn and Cattle, of a good and temperate Air, and inhabited by a People of a good natural Disposition, of good Parts, and famous for their Courage.

It is divided into Six Circuits, viz.

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Western Circuit,	} Chief Towns	Salisbury.
Oxford D ^o .		Oxford.
Home ———		Canterbury.
Norfolk ———		Norwich.
Midland ———		Lincoln.
North ———		York.

Western Circuit contains,

Cornwal,	} Chief Towns	Launceston.
Devonshire,		Exeter.
Dorsetshire,		Dorchester.
Hampshire,		Winchester.
Somersetshire,		Bristol.
Wiltshire,		Salisbury.

Oxford Circuit contains,

Berkshire,	} Chief Towns	Reading.
Oxfordshire,		Oxford.
Glocestershire,		Glocester.
Monmouthshire,		Monmouth.
Herefordshire,		Hereford.
Worcestershire,	} Chief Towns	Worcester.
Staffordshire,		Stafford.
Shropshire,		Shrewsbury.

Home Circuit contains,

Essex,	} Chief Towns	Colchester.
Hertfordshire,		Hertford.
Kent,		Canterbury.
Surry,		Southwark.
Suffex,		Chichester.

Norfolk

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Norfolk Circuit contains,

Norfolk,	} Chief Towns	Norwich.
Suffolk,		Ipswich.
Cambridgeshire,		Cambridge.
Huntingdonshire,		Huntingdon.
Bedfordshire,		Bedford.
Buckinghamshire,		Buckingham.

Midland Circuit contains,

Lincolnshire,	} Chief Towns	Lincoln.
Nottinghamshire,		Nottingham.
Derbyshire,		Derby.
Rutlandshire,		Okeham.
Leicestershire,		Leicester.
Warwickshire,		Warwick.
Northamptonshire,		Northampton.

North Circuit contains,

Yorkshire,	} Chief Towns	York.
Durham,		Idem.
Northumberland,		Newcastle.
Lancashire,		Lancaster.
Westmoreland,		Appleby.
Cumberland,		Carlisle.



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Of WALES.

Wales is a Principality, and is divided into four Circuits, each comprehending three Counties ;

	First,	
Denbeighshire,	} Chief } Towns	{ <i>Denbeigh.</i> <i>St. Asaph.</i> <i>Montgomery.</i>
Flintshire,		
Montgomeryshire,		

	Second,	
Anglesey,	} Chief } Towns	{ <i>Bedumaris.</i> <i>Carnarvon.</i> <i>Harlech.</i>
Carnarvonshire,		
Merionethshire,		

	Third,	
Cardiganshire,	} Chief } Towns	{ <i>Cardigan.</i> <i>Caermarthen.</i> <i>Pembroke.</i>
Caermarthenshire,		
Pembrokeshire,		

	Fourth,	
Radnorshire,	} Chief } Towns	{ <i>Radnor.</i> <i>Brecknock.</i> <i>Cardiff.</i>
Brecknockshire,		
Glamorganshire,		

Of SCOTLAND.

Scotland is bounded on the North with the *North Sea*, on the South with *England*, on the East with the *German Ocean*, and on the West with the *Irish Sea* ; it is in length about 250 *Italian Miles*, and in breadth about 180.

It

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It is a Country vastly capable of Improvements, and abounds with Pasture and Corn, but for the most part, is a very mountainous barren Soil, and of a very cold Air; but what it wants in Richness of Soil it makes amends for in its Inhabitants, who are generally of good natural Parts, and universal Education: It is divided into two Classes, viz. *South* the *Frith*, chief Town *Edinburgh*; and *North* the *Frith*, chief Town *Aberdeen*.

South Class comprehends,

Galloway,
Nithisdale,
Anandale,
Ethdale with Eas-
Lidisdale, [dale,
Tivivotalc,
The Mers,
Lauderdale,
Tweedale,
Clydesdale,
Kyle,
Carrick,
Lothian,
Sterling,
Renfrew,
Cunningham,
Isles of } *Boon*,
 } *Arren*,
Penins. of Cantyre.

Chief
Towns

Kirkudbright,
Dumfries.
Annand.

Hermitage,
Fedbourg.
Dans.

Lauder.
Peeblis.

Glasgow,
Aire.

Bargenny.
Edinburgh.

Idem.
Idem.

Irwin.
Rothsey.

Kilkeran.

North

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North Class comprehends,

Fife,
 Monteith,
 Lennox,
 Argile,
 Perth,
 Strathern,
 Broad-Albain,
 Lorn,
 Merns,
 Angus,
 Gaury,
 Athole,
 Marr,
 Badenock,
 Locabar,
 Buchan,
 Bamfe,
 Murray,
 Ross,
 Sutherland,
 Strathnaver,
 Caithness,

Chief
 Towns

St. Andrews.
Dumblain.
Dumbarton.
Innerara.
Idem.
Abernethy.
Dunstaffag.
Bervay.
Dundee.
Blair.
Aberdeen.
Riven.
Innerjocky.
Peterhead.
Idem.
Elgin.
Tain.
Dornock.
Strathby.
Wick.

OF IRELAND.

Ireland is situated between the 7 and 12° 10' of *Longitude*, and between the 51 and 55 Deg. 25 Min. of *North Latitude*, and is from North to South 265 Mile, and from East to West about 150 Miles.

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It is in general but an indifferent Country, in some Parts fertil and pleasant; about the same Degrees of Heat and Cold as *England*, mix'd with Mountains and Champaign, and provided with good Rivers; but for the most Part very full of Lakes, Woods, and Morass, which render it, in those Parts, unpleasant and unwholsome; but it is inhabited by a People of noted Courage. It is divided into four Provinces, viz.

Province of *Lemster* contains

Louth County,	} Chief Towns	<i>Drogheda.</i>
Dublin,		<i>Idem.</i>
Wicklow,		<i>Idem.</i>
Wexford,		<i>Idem.</i>
Longford,		<i>Idem.</i>
Meath County,		<i>Molingar.</i>
King's County,		<i>Philipstone.</i>
Queen's County,		<i>Mariburrow.</i>
Kilkenny,		<i>Idem.</i>
Kildare,		<i>Idem.</i>
Caterlagh,		<i>Idem.</i>

Province of *Ulster* contains

Down County,	} Chief Towns	<i>Down.</i>
Armagh,		<i>Idem.</i>
Monogon,		<i>Idem.</i>
Caven,		<i>Idem.</i>
Antrim,		<i>Carrickfargus.</i>
Londonderry,		<i>Idem.</i>
Tirone County,		<i>Dunganon.</i>
Fermanath,		<i>Inniskilling.</i>
Dunnagal,		<i>Idem.</i>

Province

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Province of *Connaught* contains

<i>Letrim,</i> <i>Roscommon,</i> <i>Galloway,</i> <i>Maio County,</i> <i>Slego,</i>	Chief Towns	<i>Idem.</i> <i>Athlone.</i> <i>Idem.</i> <i>Maio.</i> <i>Idem.</i>
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Province of *Munster* contains

<i>Tipperary,</i> <i>Waterford,</i> <i>Clare County,</i> <i>Limerick,</i> <i>Cork County,</i> <i>Kerry,</i>	Chief Towns	<i>Clonmel.</i> <i>Idem.</i> <i>Idem.</i> <i>Idem.</i> <i>Idem.</i> <i>Dingle.</i>
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Of the lesser ISLES of *England*, *Scotland*,
and Ireland.

THERE are great Numbers of Isles off the Coast of *England*, the Chief of which are ;

1. On the East on the Mouth of the *Thames* and *Medway* off *Feversham*, the Isle of *Shepey*.
2. On the North East of *Kent* off *Sandwich*, the Isle of *Thanet*.
3. On the West of *St. Bees Head* in the *Irish Sea*, is the Isle of *Man*.
4. On the West in the same Sea of *Bangor*, the Isle of *Anglesey*.
5. On the West in *St. George's Channel* off the *Land's End*, the *Sorlings*, or the Isles of *Scilly*.
6. On the South in the Channel of *Weymouth* in *Dorsetshire*, the Isle of *Portland*.
7. In the same Sea of *Southampton* in *Hampshire*, the Isle of *Wight* :

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Wight: On the South of *Portland* on the Coast of *France*, the *Isles of Guernsey, Jersey, and Alderney.*

The lesser *Isles of Scotland* are very numerous; of the *Orcades* 26 are inhabited, besides many others which are not; and the Western *Isles* above 300. Of the *Orcades* the Chief are, *Hoy, Mainland, Sapinsha, and Westra.* Of the *Isles of Shetland, Mainland, and Fell.* And of the Western *Isles, Lewes, Wüß, Sky, Mul, Fura, and Ila.*

The chief *Mountains in Britain* are, the *Grampion Hills in Scotland, the Cheviot Hills between Scotland and England, the Malvern and the Peak in England; the Snow Down and Plinlimmon in Wales; and Knock Patrick in Ireland.*

The chief *Rivers* are, in *Scotland, the Tay, Clyd, Spey, Dee, and Don.*

In *England; the Thames, Severn, Humber, Tyne, Medway, and Cam.*

In *Ireland; Shannon, Lee, Blackwater, Barrow, and Boyn.*





S E C T. IV.

Containing the Divisions of A S I A.

A *S I A* is bounded Eastward by the *Eastern* or *Pacifick Ocean*, lying between it and *America*, Southward by the *Indian Ocean*; Westward, it is separated from *Africa* by the *Red Sea*; the *Mediterranean Sea*, and the *Isthmus*, lying between them: From *Europe* by the Bounds already mentioned in the Description of *Europe*: It is situated between the 55 and 180 Deg. of *Longitude*, and between the 1 and 72 of North *Latitude*; and is about 6460 *Italian Miles* long, and 4320 *Miles* broad, and is generally divided into five principal *Parts*, viz.

Tartary,	} Chief Towns	<i>Chancbahu.</i>
China,		<i>Pekin, or Xuntien.</i>
India,		<i>Agra.</i>
Persia,		<i>Ispahan.</i>
Turky in Asia,		<i>Aleppo.</i>

To these add the *Assiatick Islands*; of each in their Order.

Of TARTARY.

IT is situated between 77 Deg. 10 Min. and 163 Deg. 13 of *Longitude*, and between the 37 and 75 Deg. of North *Latitude*.

Its Length from East to West is about 3000 Miles, and Breadth from North to South about 2250.

And it is, in general, a very unpleasant, barren, unwholsome Country, of a very cold, moist Air; in most Parts full of Mountains, Woods, Lakes, and Desarts; produceth some Rice, and some Grass for Feeding, but abounds with neither; and is very ill provided with Rivers: It is divided as follows;

Kathay,	{ Chief Towns }	Chambaku.
Turkestan,		Tibet.
Zagathay,		Samerchand.
Tartaria Proper,		Mongul.
Tartaria Deserta,		Cumbalich.

Its LAKES.

It has been observed, that though *Tartary* is not well watered by any great Number of large Rivers, it is in some measure made ample amends by the Number of large Lakes, with which it abounds more than any yet known Country of the World; which are as follow;

Carantia,

†

Carantia,	} Chief } Towns	Carantia.
Bervan,		Bervan.
Tzejora,		Tzejora.
Tchma,		Tchma.

Of CHINA.

CHINA is situated between 118 and 141 Degrees of *Longitude*, and between 20 Deg. 30 Min. and 41 Deg. 10 Min. of *Latitude*; and is in Length, from North to South, about 1380 Miles, and in Breadth, from East to West, about 1260 Miles. It is bounded on the North with *Great Tartary*, on the South with the *Indian Sea*, on the East with the Sea of *China*, and on the West with *India*.

China is, in general, one of the finest Countries of the World; of an Air, for the most part, temperate, and of a Soil rich, for Corn, Wine, and Fruits; and in the Mountains for Gold and Silver Mines; well watered with Rivers, and provided with Lakes, well stock'd with good Fish. It is divided into the following sixteen Provinces;

North comprehends

Leaotong,	} Chief } Towns	Leaoyang.
Xantung,		Chinan.
Peking,		Idem.
Xanfi,		Taiyven.
Honau,		Kaijung.
Xenfi,		Sigan.

South

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South comprehends,

Nanking,	} Chief Towns	Kiangnan,
Chekiang,		Hangchew.
Kiangsi,		Nanchang.
Fokien,		Fochew.
Huquang,		Unchang.
Quantung,		Quanchew.
Suchuen,		Chingtu.
Queicheu,		Queiyang.
Quansi,		Quilin.
Junnan,		Idem.

OF INDIA.

INDIA is between the *Longitude* of 92 Deg. and 131, and between 8 Deg. 12 Min. 40 Deg. of North *Latitude*; and is in *Length*, from North West to South East, about 1680 Miles, and in *Breadth*, from North to South, about 1690 Miles.

This vast complex Body, under the Title of *India*, comprehends all between *Persia* and *China*, and has many very great and distinct Kingdoms, but all reduceable to the three Divisions in the following Table;

Mogul,	} Ganges,	} Chief Towns	Agri.
India within			Golconda.
India without			Pegu.

Of which in their proper Order.

Of the MOGUL EMPIRE.

THIS Empire is bounded on the North with *Tartary*, on the South with the *Indian Ocean*, on the East with *India on this Side the Ganges and Tartary*, and on the West with *Tartary and Persia*: The chief Kingdoms in it are,

Delly,	} Chief } Towns	{ <i>Idem.</i> <i>Idem.</i> <i>Surat.</i> <i>Idem.</i>
Agra,		
Gururat,		
Bengala,		

This Part of *India* consists in the greatest Extreame, for towards the North it is very cold, and very barren; towards the South very plentiful for Corn, Rice, and Fruits.

INDIA within the Ganges is bounded on the North with the *Mogul*, on the South with the *Indian Sea*, on the East with the Gulf of *Bengal*, and on the West with that of *Mare Arabicum*; and contains the Kingdoms of

Decan,	} Chief } Towns	{ <i>Goa.</i> <i>Idem.</i> <i>Calicut.</i> <i>Idem.</i>
Galcond,		
Malabar,		
Bisnagar,		

INDIA without the Ganges is bounded on the North with Part of the *Mogul's Empire*,

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pire, on the South with the Streights of *Malacca*, on the East with the Gulf of *Tonquin*, and on the West with the Gulf of *Bengall*; and contains the Kingdoms of

Pegu,	}	Chief Towns	Idem.
Tonquin,			Idem.
Cochinchin,			Idem.
Siam,			Idem.

INDIA, taken together, may justly be said to be an Abridgment of the whole World, containing something of the best and worst of all the other Parts, viz. The Treasures of *America*, the Garnery of *Europe*, the Mountains, Heats, and Serpents of *Africa*, and more Toys, Pearls, precious Stones and Diamonds than all the World besides.

Of PERSIA.

PERSIA is bounded on the North with *Georgia*, the *Caspian Sea*, and *Tartary*; on the South with *Arabia*; on the East with *India*, and on the West with *Turkey in Asia*; and is between 70 and 97 Deg. of *Longitude*, and between 25 Deg. 40 Min. and 44 Deg. 30 Min. of *Latitude*; and is from East to West about 1440 Miles, and from North to South 1260 Miles.

Few, if any, Countries in the World, bear so different a Character as this; the North and

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East Parts being very mountainous, sandy, and desert; the South and West a level and rich Soil, but for several Months extremely hot: But in general, is said to be a fine Country, abounding with all the Pleasures, as well as the Necessaries of Life; and the People are naturally civil and of good Sense: It is divided into many Provinces, but chiefly the following;

North comprehends

Scirvant,	} Chief	{	<i>Derbent.</i>
Giland,			<i>Gilan.</i>
Cheraffan,			<i>Heret.</i>

Middle comprehends

Erach,	} Chief	{	<i>Ispahan.</i>
Sablestan,			<i>Bof.</i>
Sigistan,			<i>Sitzistan.</i>

South comprehends

Cusistan,	} Chief	{	<i>Susa.</i>
Fars,			<i>Schiras.</i>
Kirman,			<i>Gombroon.</i>
Macran,			<i>Titz.</i>

Of TURKEY in ASIA.

IT is bounded on the North with the *Euxine* Sea, on the South with the *Arabian* Sea, on the East with *Persia* and the *Persian* Gulf, and on the West with *Egypt*; and lies between

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tween 48 and 82 Degrées of *Longitude*, and between 13 Deg. 30 Min. and 45 Deg. 30 Min. of *Latitude*; and is, from South East to North West, about 2100 Miles long; and from North to South, about 1740 Miles broad.

It may be justly said of this Country, that where it is good, there is none better; and where it is bad, there is none worse. For in *Natolia*, *Syria*, *Georgia*, and *Arabia Felix*, it is, for the most part, a very good Country, of a rich Soil, for every thing for the Nourishment and Pleasures of Life.

But it is, in general, mountainous, and in other Parts, a very barren Soil and unwholesome Air, lying waste and uncultivated, or, which is worse, inhabited by a barbarous People, the *Saracens* or *Wild Arabs*. It is generally divided into six Parts, viz.

Natolia,	} Chief Towns {	Bursa.
Arabia,		Medina.
Syria,		Aleppo.
Diarbeck,		Bagdat.
Turcomania,		Arzerum.
Georgia,		Teflis.

Of the Asiatick Islands.

THE Islands that belong to *Asia* are so very numerous, that, perhaps, one twentieth Part of them have hardly been ever seen

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by any *European*, and of consequence the Accounts of them must be very uncertain, they are by some reckon'd to be about 150,000 in Number, but that Account must needs depend only upon Conjecture; but some that are large and peopled are very well known, and are as follow;

Japan Isles.

Tonfa,
Japan,
Bongo,

} Chief } *Tosa.*
} Towns } *Meaco.*
 } *Bongo.*

These are, for the most part, very mountainous and wood-land, and of a cold Air, but very wholesome; and of a plentiful Soil, rich in Gold and Silver, &c. Near to which joyns the Island of *Formosa*, about 51 *Italian Miles* long and 45 broad.

Philippine Isles.

Lucon,
Mindanao,
Pulcan,
Achan,

} Chief } *Idem.*
} Towns } *Idem.*
 } *Idem.*

These and many more about them are generally blessed with a good Soil for Corn, Rice, Fruits, Sugar, Spice, and some with Gold.

There

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There are likewise a vast Number of Islands off the Coast of *Malabar*, which are called the *Maldivian Isles*; the Chief of which are,

Ceylon,	}	Chief	}	<i>Candea.</i>
Male,		Towns		

The *Maldives*, though many of them are under the same Parallel of *Latitude*, yet are of a very different Nature, and are generally hot, and barren of every thing, except Cocoa-Nuts and some other Fruits. But *Ceylon* is so fruitful of Corn, &c. so pleasant and healthful, that the *Indians* have named it, the *Land of Delights*.

Islands of *Sundi* are,

Sumatra,	}	Chief	}	<i>Achem.</i>	
Java,				Towns	<i>Materam.</i>
Borneo,					<i>Borneo.</i>

These Islands make generally a very pleasant Landskip, and are of a very fruitful Soil for Corn, Fruits, Spice, Pasture, &c. and are therefore reckon'd some of the Chief of the Spicy Islands, and are not without Gold and Silver.

The *Molucca* or *Spice Islands* are very many in Number, the Chief of which are,

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Celibes,	} Chief Towns	<i>Idem.</i>
Gilola,		<i>Idem.</i>
Cerum,		<i>Cimbelo.</i>
Flores,		<i>Lusitaia.</i>
Amboyna,		<i>Idem.</i>
Timor,		_____

These Islands, by their Situation, must be extremely hot, and the Air is generally esteem'd very unwholsome, and the Soil barren of Corn and Pastures, but abounding in rich Spices and Mines of Gold.

There are, besides these, many other large and populous Islands near the Continent of *Asia*, of which the *Europeans* know but little, and what Accounts we have yet of them are little better than Conjecture.

The chief Mountains in *Asia* are, the *Imaus* in *Tartary*, the *Caucasus* between *Tartary* and the *Mogul's* Empire, the *Taurus*, reaching from East to West of all *Asia*, and *Adam's Pike* in the Island of *Ceylon*.

The chief Rivers in *Asia* are, the *Indus*, *Ganges*, *Oby*, *Tygris*, and *Euphrates*.





S E C T. V.

-Containing the Divisions of AFRICA.

AFRICA is situated between the 3 and 83 Deg. of *Longitude*, and between the 35 Deg. 30 Min. North, and 35 Deg. 30 Min. South *Latitude*; and is bounded on the North with the *Mediterranean Sea*, on the South with the *Ethiopic Ocean*, on the East by the *Isthmus of Suez* and the *Red Sea*, and with the *Western Ocean* on the West: It is about 4800 *Italian Miles* long, and about 4200 broad. The chief Rivers of which are, the *Nile*, the *Niger*, the *Nubie*, the *Zain*, and the *Zambre*; and the Mountains those of *Atlas* and *Teneriff*; and is generally divided into the following Kingdoms;

Barbary,
Egypt,
Bildulgerid,
Sarraz,
Land of the Negroes,
Guiney,
Nubia,
Ethiopia Interior,
Ethiopia Exterior,

Chief
Towns

Fez.
Alexandria.
Dara.
Zunziga.
Tombute.
Arda.
Duncala.
Camur.
Monomotapa.

Of each of which in their Order.

of

OF BARBARY.

BARBARY is situated between the 8 and 60 Deg. of *Longitude*, and between the 28 Deg. 25 Min. and 35 Deg. 30 Min. of *Latitude*; and is bounded with the *Mediterranean* on the North, with Mount *Atlas* on the East, and with the Kingdom of *Barca*, and on the West with the *Atlantick Ocean*.

This Country, though mountainous and woody, is the best, next to *Egypt*, of all *Africa*, lying upon the Sea: The Air temperate, and the Soil rich, and fit for Corn, Wine, Fruits, and Pasture, and well watered about the Coasts with small Rivers.

It is divided into six Kingdoms; which are,

Morocco,	} Chief Places	<i>Idem.</i>
Fez,		<i>Idem.</i>
Algiers,		<i>Idem.</i>
Tunis,		<i>Idem.</i>
Tripoli,		<i>Idem.</i>
Barca,		<i>Idem.</i>

OF EGYPT.

EGYPT is situated between the 59 Deg. 20 Min. and 67 Deg. 30 Min. of *Longitude*, and between the 21 Deg. 30 Min. and 31 Deg. 50 Min. of North *Latitude*; and is bounded

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bounded on the North with the *Mediterranean*, on the South with *Nubia*, on the East with *Asia* and the *Red Sea*, and on the West with *Barca* and *Barbary*.

This Country, especially about the *Nile*, is one of the most plentiful Countries of the World, that River enriching the Land that lies upon it extremely; but the inland Country on both Sides is very sandy and barren, and lyes waste, and destitute of all Water, except a few Springs; and the Air is very hot and unwholsome: It is divided into the Provinces of

Erise,	}	Chief Towns	{	<i>Alexandria.</i>
Bactria,			{	<i>Cairo.</i>
Satrid,			{	<i>Idem.</i>
Coast of Red Sea,			{	<i>Cosm.</i>

OF BILDULGERID.

IT is situated between the 50 and 60 Deg. of *Longitude*, and between the 21 Deg. 45 Min. and 32 Deg. of North *Latitude*; and is bounded on the North by *Barbary*, on the South by a very great Desert, call'd, the *Desert of Zaara*; on the East by *Nubia* and *Egypt*, and on the West by the *Atlantick Ocean*.

This Country is generally very barren and sandy; and very hot, especially, in the *Desert of Zaara*, where Travellers are often put to great

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great Extremities; but yet to the Natives the Air is said to be wholsome, and in the Vales of *Bildulgerid*, the Soil is accounted very fruitful: It is divided into the Provinces of

Tesset,	} Chief Towns	<i>Tesset.</i>
Dara,		<i>Dara.</i>
Segelmess,		<i>Segelmess.</i>
Tegorarin,		<i>Tegorarin.</i>
Zeb,		<i>Teulacher.</i>
Bildulgerid,		<i>Capheffa.</i>
Desart of Barca,		

Of Sara or Negroland, and Nubia.

NEGROLAND is between the 3 and 44 Deg. of *Longitude*, and between the 8 and 23 Deg. of North *Latitude*; it is bounded on the North with *Zaara*, on the South with *Guiney*, on the East with *Nubia*, *Borno*, and *Biafar*, and on the West with the *Atlantic* Ocean.

Nubia is situated between the 48 and 65 Deg. of *Longitude*, and between the 10 and 23 Deg. of South *Latitude*; and is bounded on the North with *Egypt* and *Barcu*, on the South with *Ethiopia* and *Abyssina*, on the East with *Egypt*, and on the West with the *Desart* of *Zaara*.

Each of these Countries hath a River which much enriches the Parts that lie about it, but in other Parts they are both barren Countries; but

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but *Nubia* is much the worst, and is, as well as *Negroland*, very mountainous.

But *Negroland* is, in general, very rich in Corn, Cattle, and Gold, and is accounted very wholesome to live in, insomuch, that the People from other Parts repair to it to recover their lost Health: It is divided into the Provinces of,

Genahoa,
Galala,
Tombute,
Agades,
Cano,
Cassena,
Guangara,
Melli,
Mandinga,
Gago,
Guber,
Zegreg,
Zanfara,

} Chief } The same with
} Towns } the Provinces.

Of GUINER.

IT is situated between the 9 and 36 Deg. of *Longitude*, and between the 4 Deg. 40 Min. and 12 Deg. 25 Min. of South *Latitude*; is bounded on the North with *Ethiopia* and *Negroland*, on the South with the Ocean, on the East with the Kingdom of *Biaffor*, and on the West with the *Atlantick* Ocean.

It

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It is very hot, and were it not for that, it would be a very fine Country, the Soil being very rich, and fit for Corn, Rice, and Pasture; and the Rivers and Mines very rich in Gold and Pearl; but the Air is very unwholsome for Strangers to live in, and vast Numbers of Europeans dye there in the Factories upon the Coasts: It is divided into three Parts, as,

Benin,
Malequette,
Guiney,

} Chief } *Arda.*
} Towns } *Timan.*
 } *Tabé.*

Of Interior Ethiopia, or the Kingdom of the Abyssins.

IT is situated between the 48 and 74 Deg. of *Longitude*, and between the 14 South and 20 of North *Latitude*; and is bounded on the North with *Egypt* and *Nubia*, on the South with the Empire of *Monomugi*, on the East with the Coast of *Zanguebar*, and on the West with *Congo* and *Biafar*, &c.

In the Parts which lie upon the *Nile*, it is a very rich Country, but those that lie remote from it are barren and desert, and of a very hot Air: It is divided into the Provinces of,

Barnagasso,

Barnagasso,	} Chief Towns	<i>Barva.</i>
Tigremahon,		<i>Caxhumo.</i>
Dobassat,		<i>Dobas.</i>
Fatigar,		<i>Fatigar.</i>
Anyote,		<i>Amara.</i>
Amara,		<i>Idem.</i>
Beleguanze,		<i>Idem.</i>
Bagamedri,		<i>Idem.</i>

OF ETHIOPIA EXTERIOR.

IT is situated between the 34 and 80 Deg. of *Longitude*, and between the 19 North, and 35 of South *Latitude*; and is bounded on the North by *Abyssino*, *Negroland*, and *Egypt*; on the East, West, and South by the *Ethiopic Ocean*.

There is a great Variety in this Country, according to the Situation of it, *Monomugi* and *Monomotapa* are temperate and fruitful, and in *Zanguebar* it is very unwholsome: It is divided into the Kingdoms of,

Biafara,	} Chief Towns	<i>Idem.</i>
Loango,		<i>Idem.</i>
Congo,		<i>St. Salvador.</i>
Angola,		<i>Idem.</i>

And the Empires of,

Monomugi,	} Chief Towns	<i>Camur.</i>
Monomotapa,		<i>Idem.</i>

And

†

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And the Coasts of,

Cafres,	} Chief	Cofala.
Zanguebar,		Melinda.
Ajan,		Brava.
Abex.		Ereuo.

The Islands of *Africa* are those of *Madagascar*, *St. Maurice*, *Bourbon*, and *Zocotora*, which lie off the Coast of *Zanguebar*; that of *Madagascar* is the largest in the World, being 990 Miles in Length, and 300 in Breadth.

Those on the West of *Africa* are, the *Maderas*, *Cape de Verd*, and *Canary Islands*; *St. Helena*, and *St. Thomas*.

Madera Isles.

Madera,	} Chief	Funchale.
Porto Santo,		Porto Santo.
La Deferta,		—

Cape de Verd Isles.

St. Anthony,	} Chief	St. Cruz.
St. Vincent,		Great N. W. Bay.
St. Lucia,		Best Haven.
St. Nicholas,		Port of Pergicica.
St. Jago,		St. Jago.
Isle de Sel,		West Haven.
Isle of May,		Water Valley.
Del Fuego,		Hermitage.
Brava,		—
Bona Vitar,		—

The

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The *Canary* Isles are about Fourteen in Number, the Chief of which are,

Lanzarote,	} Chief Towns	Idem.
Forteventura,		<i>Calette de Fustes.</i>
Canaria,		Idem.
Teneriffe,		<i>St. Cruz.</i>
Gomera,		Idem.
Ferro,		-----
Palma,		<i>St. Cruz.</i>

These Islands are, for the most part, rich and fruitful for Corn, Fruits, Sugar and Wine, &c. and *Madagascar* is well stor'd with Metals; but the *Cape de Verd* Islands are generally unwholsome.

There are some Islands on the North of *Africa* which belong to it; the Chief of which is the Isle of *Malta*, 35 Miles long and 30 broad, and is but a poor Soil, of a hot sultry Air, producing little but Cotten, Wool, Ani-seed, Cumminseed, &c. but is well supply'd from *Sicily*.





S E C T. VI.

Containing the Divisions of AMERICA.

A M E R I C A is situated between the 240 and 348 Degree of *Longitude*, and between the 63 of North and the 55 of South *Latitude*: It is about 7000 *Italian Miles* in Length, and 3360 Miles broad, though in some Places it is not above 60.

The chief Rivers of it are, *De la Plate*, *Amazons*, *Orinoque*, and *Canada*; and the Mountains are those of the *Andes*, which reach some thousands of Miles, and *Apalachin*. It is divided into two Parts,

Viz. { *North America*,
and
South America.

North America is divided into five Parts,
viz.

Mexico, or *New Spain*,
New Mexico, or *Granada*,
Florida,
Canada,
Terra Arctica.

Of

Of MEXICO or NEW SPAIN.

M*XICO* is situated between the 254 and 293 Deg. of *Longitude*, and between the 7 Deg. 20 Min. and 29 Deg. 4 Min. of North *Latitude*; and is bounded on the North with *Florida*, on the South with the *South Sea*, on the East with *Terra Firma* and the Gulf of *Mexico*, and on the West with the *South Sea*. It is about 2460 Miles long, and 760 broad.

It is a very fine Country, but somewhat mountainous, but for the most part champaign. The Air, though in the *Torrid Zone*, temperate and healthful, and the Soil rich for Corn and Fruit, and in some Parts for Gold and Silver Mines; well watered with Rivers and Lakes, and inhabited by a People naturally civil. It is divided into three great Parts or Audiences of

Guadalajara,
Mexico,
Guatimala.

The Provinces of *Guadalajara* are those of,

Cinaloa,
New Biscay,
Zocateca,
Guadalajara,
Chiameltan,
Xalisco.

Chief Towns {
St. Juan.
St. Barbara.
Zacatecas.
Idem.
St. Sebastian.
Compostella.

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The Provinces of Mexico are those of,

Panuco,	} Chief Towns	Idem.
Mexico,		Idem.
Mechoacan,		Idem.
Los Angeles,		Idem.
Antequera,		Idem.
Tabasco,		Port-Royal.
Jucutan		Merida.

The Provinces of Guatimala are those of;

Soco Nufco,	} Chief Towns	Guevetland.
Guatimala,		St. Pagod, Idem.
Nicaragua,		Leon.
Costa-riga,		Cartbage.
Veragua,		Conception.
Honduras		New Valladolid.
Vera-Pax,		Idem.
Chiapa		Cioidad Real.

Of NEW MEXICO or GRANADA.

THE Extent of this Country is as yet but very little known; no good Account can be given of the Soil or Product in General, but where it is known, it is said to be very indifferent; dry, sandy Ground, notwithstanding which, the Air is said to be temperate and wholsome. Its chief Town is St. Fee.

Of

Of *FLORIDA*.

IT is situated between the 26⁹ and 29⁴ Deg. of *Longitude*, and between the 25 and 40 Degree of *Latitude*, North. It is bounded on the North with *Canada*, on the South with the Gulf of *Mexico*, on the East with the *Main Ocean*, and on the West with *New Granada*, and is in Length about 1200 *Italian Miles*, and in Breadth 600.

Florida is generally a very fine Country, mountainous towards the East-End and Sea-Coasts, but within Land, for the most Part, a fine plain Country, mixt with Woods, Lawrels, Cedars, Palms, and Cypress, &c. of a good temperate Air, producing fine Grain and Fruits, and has some Mines of Gold and Silver, and has some good Rivers and Lakes, but fill'd with Lions, Leopards, and Serpents, of a prodigious Size.

It is divided into 43 *Provinces*, but being little known, their Names are not set down; but there are 14 *Spanish* and 5 *English* Colonies mention'd.

The *English* Colonies are those of,

Old Charles Town,

Charles Town,

New London,

Cambake,

Melilot.

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The *Spanish Colonies* are those of,

St. Mattheo,	} <i>on the East.</i>
St. Augustin,	
Arhalaqua,	
Offachile,	
Hirritique,	
Colima,	} <i>on the West.</i>
Capaha,	
Coza,	
Tascaluza,	
Quigata,	
Xualitino,	
Chagus,	
Maquater,	

Of CANADA.

IT is situated between the 266 and 330 Deg. of *Longitude*, and between the 40 and 63 Deg. of *North Latitude*, and is bounded on the North with the North Sea, on the South with *Florida*, on the East with the North Sea, and on the West with *New Mexico*. It is about 2700 *Italian Miles* long, and 1500 broad.

It is a Country which consists of great Variety, but in general is a good Country, and agreeable to our Northern Constitutions, mountainous, marshy, and rocky in many Parts, but has plenty of good Pasture, and Corn Land, well water'd with good Rivers, and

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and which produceth good Store of Grain and Fruits, and some Mines of Silver; and the Woods, with which it also abounds, are stock'd with good Venison.

Canada is divided into North and South, the first of which is divided into Three Parts, and the last into Eight.

In North *Canada* the Provinces are,

Canada,	}	Chief Towns	{	_____	:
New Britany,				_____	:
New France,				<i>Quebec.</i>	:

In South *Canada* are the Provinces of

New Scotland,	}	Chief Towns	{	<i>Port-Royal.</i>
New England,				<i>Boston.</i>
New York,				<i>New York.</i>
New Jersey,				<i>Elizabeth.</i>
Pensilvania,				<i>Philadelphia.</i>
Maryland,				<i>St. Mary's.</i>
Virginia,				<i>James Town.</i>
Carolina,				<i>Charles Town.</i>

Besides which are about 75 Towns belonging to the *English*.

Of TERRA ARCTA.

Under this Name are comprehended all the Countries which lie either entirely, or for the most part within the Circle of the

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North Pole; such as, *Greenland, Spitzberg, Nova Zembla, Terra Jesso, New Denmark, New North Wales*, and there is nothing yet certainly known of the Bounds, Extent, Situation, or Nature of these Countries.

The Islands of *North America* are pretty numerous, and lie on all Sides of it; the Chief of which are those of *Iceland, Greenland, Anticosti, or Assumption*, and the Isle of *Newfoundland*, the Isle of *Manahatten*, and *Staten*, Isle of *New-York*; the Isle of *Bermudas*, off of *Carolina*, and the Isles of *Lucayes* or *Bahama* off of the Cape of *Florida*, the Isles of *Cuba, Hispaniola, Jamaica* at the Mouth of the Gulf of *Mexico*, off of *New Spain*; and a little more Eastward are the *Carribe Islands* off from *Hispaniola* and *South America*, with several other small Islands; and on the Western Side of the Continent are many more, the Chief of which are on both Sides the following,

Iceland,	} Chief Towns	<i>Statbolt.</i>
Assumption,		-----
Newfoundland,		<i>Conception-Bay.</i>
Manahatten,		<i>New-York.</i>
Staten I.		-----
Bermudas,		-----
Cuba,		<i>Havana.</i>
Jamaica,		<i>Port-Royal.</i>
Hispaniola,		<i>St. Domingo.</i>
Porto Rio,		<i>St. Germans.</i>
California	}	<i>California.</i>
Long I.		<i>Dover.</i>

Besides

Besides these are the *Cumberland Isles*,
St. Thomas and *Coco*, &c.

Of the rest of the CARIBBE ISLANDS.

These are Thirty in all, the Chief of
 which are,

Anguilla,	St. Martin,
Barbada,	St. Croix,
Antegoa,	St. Christopher,
Montserat,	Nevis,
St. Dominica,	Guardelupe,
Barbadoes,	Marignante,
St. Vincent,	Martinico,
Tobago,	St. Bartholemew.

Nigh these are the *Lesser Antille's*, or *Lee-ward Islands*, being Eight in Number, as follow,

Margaritta,	Trinadada,
Bonayre,	Urchila,
Curassaw,	Roca,
Tortuga,	Oruba,



Of SOUTH AMERICA.

South America is divided into,

Terra Firma,	} Chief Towns	Paraguay.
Peru,		Terra Magellanica.
Chile,		Terra Artica.
Brazil,		-----
Amazons,		-----

Of TERRA FIRMA.

IT is situated between the 293 and 329 of *Longitude*, and between 10 Deg. 40 Min. and 2 Deg. 40 Min. South, and is bound-
ed on the North by *Mer del Nort*, and the Bay of *Mexico*; on the South with *Peru* and *Amazons*; on the West with the *Isthmus* of *Darien* in *New Spain*, and on the East with the *North Sea*; is about 1260 Miles long, and about 700 broad.

It is in general but an indifferent Country, tho' the Soil is rich enough, both for Corn and Fruits, Gold and Silver, and some precious Stones, and it has also good Rivers, but the Air is very hot, and the Mountains and Woods frequented by Wild Beasts by Land, and the Rivers fill'd with Crocodiles, and the Natives barbarous and very Thievish; it is divided into the following Provinces,

Caribana,

Caribana,
Guiana,
Panama,
Cartagena,
St. Martha,
Rio de la hacha
Venezula,
Andalusia,
Paria,
Granada,
Popayan,

Chief
Towns

Manoa.
Moapvers.
Idem.
Idem.
Idem.
Idem.
Idem.
Corduba.
Malu Reguara.
St. Fe di Bagula.
S. Fe di Antiochie.

Of P E R U.

PERU lies between the 390 and 307 Degree of *Longitude*, and between the 25 Deg. 30 Min. of South *Latitude*, and 1 Deg. of North *Latitude*. It is in Length from North to South about 1440 Miles, and from East to West about 48 Miles, and is bounded on the East by *Amazonia*, on the West by *Mer del Zur*, on the South by *Chili*, and on the North with *Terra Firma*.

It is a very rich fruitful Country, for Corn, Fruit, and Pasture, and has such rich Mines of Gold and Silver in the Mountains, that it may be justly term'd the Treasure of *India*; but withal it is very hot, and towards the Coast Barren and Desert, and subject to Earthquakes, and is divided into the Provinces of,

Posto,

Posto,	Chief Towns	Posto.
Los Quixos,		Baesa.
Pacamores,		Valladolid.
Quito,		Idem.
Peru,		Lima.
Los Carcas,		Paragisi.

Of the Land of A M A Z O N S.

THIS vast Country is of uncertain Extent or Division, and consequently has no chief Town, being as yet known to the Spaniards by little more than the Name; but the Parts of it that are known, are accounted a fine Country, and of a temperate Air.

Of B R A Z I L.

BRAZIL is situated between the 322 and 346 Deg. of Longitude, and between 1 and 23 Deg. of South Latitude, being in Length from North East to South West about 1600 Miles, and from North to South 1380 Miles. It is bounded on the North by *Terra Firma*, on the South by *Paraguay*; on the East by Part of the *Main Ocean*, and on the West by *Amazonia*.

A great Part of this great Country is yet undiscovered, but what of it is yet known is a very fine Country, and about the Sea Coast partly Mountainous and partly Champaign, of a good Soil for Fruits and Grain, well water'd

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water'd with Rivers, and of a good temperate healthy Air, without the Inconvenience of wild Beasts, with which other Parts abound. It has no certain Division, but the chief Towns are,

St. Vincent

Sanctos

Angrados Reyes

St. Sebastian

Spiritu Santo

Porto Seguro

St. Salvadore

Pernambuco

Parayba.

Of CHILE

CHILE is situated between the 302 and 306 Deg. of *Longitude*, and between the 25 Deg. 30 Min. and 44 Deg. of *South Latitude*. Its Length from North to South is about 960 Miles, and from East to West about 200 Miles.

It is bounded on the North by *Pera*, on the South by *Terra Magellanica*, on the East by *Paraguay*, and on the West by the *South Sea*.

It is generally but an indifferent Country, for tho' the Vales on both Sides the Mountains, which run through the Middle of it, are of a good Soil for Grain and Fruits, and some of the Mountains rich in Gold and Silver Mines, yet in the Mountains, and many other Parts, it is of a very cold Air and barren Soil, disturbed with frequent Earthquakes, and burning Vulcanos's,

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cano's, which are very troublesome to the Inhabitants, and is divided into the Provinces of,

Chili Propria,	} Chief Towns	{ <i>St. Fago,</i> <i>Balvidia,</i> <i>Mandosa.</i>
Chili Imperial,		
Chucuito.		

Of PARAGUAY.

THIS Country lies between the *Longitudes* of 307 and 337 Deg. 40 Min. and between the *Latitude* of 12 and 37 Deg. South. It is bounded on the North with *Amazonia*, on the South with *Magellan*, on the East with the *South-Sea*, and on the West with *Peru* and *Chili*; it is in Length 1560 Miles, and in Breadth 1500 Miles.

It is a good Country, of rich Soil and healthy Air, well water'd with Rivers, which fall from all Sides of the Mountains, and especially with the rich River *La Plata*, which takes its Name from the Silver with which it abounds, and the Mountains are said to be rich in Gold Mines. It is divided into the Provinces of

Guagra,	} Chief Towns	{ <i>Ciudad Real.</i> <i>Villa Rica.</i> <i>Conception,</i> <i>St. Fago.</i> <i>Assumption.</i>
Paragaia,		
Chaco,		
Tucuman,		
Rio de la Plata,		

of

Of *TERRA MAGELLANICA*.

THIS Southernmost Part of the Continent (of *South America*, call'd also *Regio Patagonum*) is so little known, that tho' there are many Stories told of it and its Inhabitants, they seem to be so fabulous, that nothing that has been said on that Head ought to be credited.

Of *TERRA ANTARCTICA*.

UNDER this Name is comprehended those Places which are discover'd about the South Pole, viz. The Land of *Papos*, *New Holland*, *New Guiney*, *New Zeland*, Land of *Quir*; but, as it has been observ'd, we have little more than the Knowledge of them.

Of the Islands of *South America*.

THOSE which are on the East are the two Isles of *Fernandes*, and the Isle of *Trinity*, and a few other small Islands of the Coast of *Brazil*.

Those on the West are the Isles of *Dogs*, *Tolies*, *Traytors*, *Goodhope*, *Horn*, *Water*, *Saint Peter*, and some others, which it would be needless to mention, because they are not known,

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known, either as to the Condition of the Climate or Inhabitants, we having nothing else besides the Names of them transmitted to us by People that have been that Way.

Having consider'd the Surface of the Terrestrial Globe, as divided into Land and Water, and each of those in their respective Sub-divisions; we shall, in the next Place, proceed to explain some of those Problems which are perform'd by the Artificial Globe.



SECT. VII.

Containing some pleasant Geographical PROBLEMS.

PROBLEM I.

To find the Latitude and Longitude of Places.

BRING the Place whose *Latitude* and *Longitude* you would know, to the brazen *Meridian*, and the Number of Degrees contain'd between the *Equator* and the Place, is the *Latitude*; and the Degrees of the *Equator*, contain'd between the first *Meridian* and the East-side of the brazen *Meridian*, is the *Longitude*, reckoning from the first *Meridian* Eastward.

Example

EXAMPLE.

To know the *Latitude* and *Longitude* of *London*; Bring the Mark for *London* to the brazen *Meridian*, and number the Degrees of the *Meridian* from the *Equator* to *London*, which is $51 \frac{1}{2}$ for the *Latitude*.

If the *Longitude* be numbred from the *Meridian* of *London*, it will have no *Longitude*; for when *London* is at the brazen *Meridian*, 'twill cross the *Equator*, where the *Longitude* begins, but if it be number'd from any other Place, where the brazen *Meridian* crosseth the *Equator*, is the Degree of *Longitude* numbred from the first *Meridian*.

PROBLEM II.

The Day of the Month being given, to find the Sun's Place in the Ecliptick.

Find the Day of the Month in the Circle of Months upon the *Horizon*, and right against it in the Circle of Signs is the Degree of the *Ecliptick* for that Day.

EXAMPLE.

I demand the Sun's Place in the *Ecliptick* for *April 20*?

First, find the 20th of *April* in the *Julian* Account, which is the innermost Circle of Months, and against it in the Circle of Signs

H

is

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is the 11th Degree of *Taurus*, which is the Sun's Place for that Day.

P R O B L E M III.

To rectify the Globe.

Find the *Longitude* of the Place for which you would rectify it, by *Problem I.* and if it be in *N. Lat.* elevate the *N. Pole* above the *N. Point* of the *Horizon*, then find the Sun's Place by *Prob. II.* mark it in the *Ecliptick*, and bring it to the *Meridian*; then set the *Horary Index* at the uppermost 12, on the *Hour Circle*; next screw the *Quadrant of Altitude* in the *Zenith* that is over the *Latitude* of the Place, and place the *Meridian North and South*, which you may do by the *Needle* on the *Horizon*; for you must turn the *Globe* till the *Needle* point just to the *Fleur-de-lys*, then is the *Globe* rectified.

P R O B L E M IV.

A Place being given, to find all those Places that have the same Latitude and Longitude.

Bring the Place to the brazen *Meridian*, then all those Places lying under that *Semicircle* have the same *Longitude*, and if you hold a *Pencil* at the *Latitude* of the Place, and turn the *Globe* round, all the Places which pass under the *Pencil* have the same *Latitude*.

B R O B L E M

P R O B L E M V.

The Day of any Month being given, to find the Length thereof in any Latitude.

Elevate the Globe for the *Latitude*, and mark the Sun's Place in the *Ecliptick*, which bring to the brazen *Meridian*, and set the *Index* to the uppermost 12 on the *Horary Circle*; then turn the Globe *Eastward*, till the Sun's Place be at the *Horizon*: The *Index* points out the Hour of Sun-rising; then turn the Globe, till the Sun's Place come to the *West Side* of the *Horizon*, and the *Index* will point out the Hour of Sun-setting; the double of the Hours of Sun-setting is the Length of the Day; and the Time of Sun-rising doubled, gives the Length of the Night.

P R O B L E M VI.

The Latitude being given, to know the Length of the longest and shortest Days.

Elevate the Globe according to the *Latitude*, and for the longest Day, if it be in *North Latitude*, mark the first Degree of *Cancer* on the Globe, and work as in *Problem V.* for the shortest Day, take the first Degree of *Capricorn*, and do as in *Prob. V.* But if the Place be in *South Latitude*, the Sun is in the first of *Capricorn* on the longest Day,

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and in the first of *Cancer* on the shortest. This Problem serves only to find the Length of the longest Days in the Temperate and Torrid Zones.

P R O B L E M VII.

Any Place being given in the Frigid Zones, to know how long the Sun shines in that Place without setting.

Elevate the Globe, according to the *Latitude* of the Place, then turn the Globe till the first of *Cancer* come under the *Meridian*, and count the same Number of Degrees upon the *Meridian* from each Side of the *Equator*, as the Place is distant from the Pole, and making a Mark where the Reckoning ends, turn the Globe round, carefully observing what two Degrees of the *Ecliptick* pass exactly under the two Points marked in the *Meridian*; for the *Northern* Arch of the Circle being reduced to Time, will give the Number of Days that the Sun doth shine above the *Horizon* of the given Place, and the opposite Arch of the same Circle will give the Number of Days in which he is absent.

P R O B L E M

P R O B L E M VHL

Any Place being given to know its Antæci, Periæci and Antipodes.

For the *Antæci*, bring the given Place to the brazen *Meridian*, and find its *Latitude* by *Problem I.* then count on the *Meridian* as many Degrees on the other Side of the *Equator*, as the Place has *Latitude*, and the Point of the Globe directly under the last of those Degrees is the *Antæci* of your Place.

For the *Periæci*, bring the given Place to the Upper, or South *Meridian*, and the Point under the same Parallel on the North *Meridian*, is the *Periæci* of the given Place.

For the *Antipodes*, bring the given Place to the North Point of the *Horizon*, and that Part of the Globe at the South Point of the *Horizon* is the *Antipodes* required.

P R O B L E M IX.

The Day and Hour being given, to find those Places of the Globe to which the Sun is in the Meridian at that time.

The *Pole* being elevated according to the *Latitude* of the given Place, bring that Place to the brazen *Meridian*, setting the *Index* of the Horary Circle to the Hour of the Day; then turn the Globe, till the *Index* point to the

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upper Figure of 12; then fix the Globe in that Situation, and all those Places under the upper half of the brazen *Meridian*, have the Sun in their *Meridian* at that particular Time.

P R O B L E M X.

The Day and Hour being given, to know what a Clock it is in any Part of the World.

Elevate the Globe to the *Latitude* of the Place you are in, and set the *Index* to the given Hour; then turn the Globe, till the proposed Place come to the brazen *Meridian*, and the *Index* will point out the Hour required.

P R O B L E M XI.

To find the Difference of Time between any two given Places.

Bring one of the Places to the brazen *Meridian*, and set the *Index* to 12, then turn the Globe till the other Place come to the *Meridian*, and the *Index* points out the Difference of Time.

The Difference of Time being known, and the Time of the Day in one, the Time of the Day in the other may be known thus; If the Place, whose Time is required, be to the *East* of the other Place, where the Time is known,
add

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add the Difference of Time to the given Time, the Sum will be that required ; but if it be to the *West*, subtract the Difference of Time from the Time given, and the Remainder will be the Time required.

P R O B L E M XII.

A Place being given on the Globe, to find those which have the same Hours of the Day with those in the given Place; as also to know where all the 24 Hours exist at one and the same Time.

Bring the given Place to the brazen Meridian, and set the Index to the Hour, then observe what Places are under the Semicircle of that Meridian ; for the People in these Places have the same Hour with the given Place. Which suppose 12, those that lie 15 Degrees East, have one a Clock ; 30 Degrees, two a Clock ; 45 Degrees make three a Clock. And by turning the Globe round, when the Index points at the several Hours, observing the Places lying under the upper Circle of the brazen Meridian, you may mark out with Chalk the 24 Meridians, where the 24 Hours exist, at one and the same time.

P R O B L E M XIII.

A Place being given in the Torrid Zone, to find those Days in which the Sun shall be Vertical to the same.

Bring the given Place to the brazen *Meridian*, and mark the Degree of *Latitude* above it; move the Globe round, and observe the two Points of the *Ecliptick* that pass through the said Degree of *Latitude*; search upon the wooden *Horizon* for those two Degrees, and opposite to them you will find the two Days on which the Sun is Vertical at the given Place.

P R O B L E M XIV.

To know the Climate of any Place.

Find the Length of the longest Day for the given Place, by *Prob. VI.* and the Number of Hours it exceeds 12, the Double of which Excess gives the *Climate* of the Place desired. But this Rule serves only for the *Torrid* and *Temperate Zones*; for if the Place, whose *Climate* is required, lie in either of the *Frigid Zones*, with the *Latitude* of the given Place, enter the Table of *Climates*, and opposite to the *Latitude* you will have the *Climate* required.

P R O B L E M

PROBLEM XV.

The Place of the Sun given, to find his Declination.

Bring the Degree of the *Ecliptick* the Sun is in, to the brazen *Meridian*, and the Degrees of that *Meridian* intercepted between the *Equator*, and the Degree of the *Ecliptick* the Sun is in, is his Declination for that Day; and bears the Denomination of *North* or *South*, according to its Position on the *North* or *South-side* of the *Equator*.

PROBLEM XVI.

The Place of the Sun given, to know his Meridian Altitude.

Rectify the Globe, bring the Degree of the *Ecliptick* the Sun is in, to the brazen *Meridian*, and the Number of Degrees contain'd between the *Horizon*, and the Sun's Place on the *Meridian*, is the Number of Degrees that the Sun is elevated above the *Horizon* at Noon,

PROBLEM

P R O B L E M XVII.

The Sun's Place being given, to find his Amplitude, and upon what Point of the Compass he riseth.

Rectify the Globe, bring the Sun's Place to the *East-side* of the *Horizon*, and the Number of Degrees intercepted betwixt the *East-point* of the *Horizon* and the Sun's Place, is the Number of Degrees of *Amplitude* at Sun-rising, and bears the Denomination either of *North* or *South*, according to its Inclination to either Point in the *Horizon*. Or if you would know upon what Point of the Compass the Sun rises, look in the outermost Circle upon the *Horizon*, which is the Circle of *Winds*; and against the Sun's Place, you have the Name of the Point of the Compass upon which the Sun riseth.

P R O B L E M XVIII.

The Day of the Month, and the Hour of the Day given, to find the Height of the Sun in any given Latitude.

Rectify the Globe, then turn it about till the *Index* point to the Hour of the Day, then bring the *Quadrant* of *Altitude* to the Sun's Place in the *Ecliptick*, and the Degree of the *Quadrant* which touches the Sun's Place, shall

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shall be the Number of Degrees of the *Sun's Altitude*.

P R O B L E M XIX.

The Altitude of the Sun, and Day of the Month given, to find the Hour of the Day.

The Globe rectified, bring the Place of the Sun to the Number of Degrees of *Altitude*, accounted upon the *Quadrant of Altitude*, and the Hour-Index will point at the Hour, in the Hour-Circle.

P R O B L E M XX.

To know when the Morning Twilight begins, and when the Evening Twilight ends.

Rectify the Globe, bring the Sun's Place to the upper *Meridian*, then the Degree of the *Ecliptick*, which is opposite to the Sun's Place, will be on the lower *Meridian*, which mark with a *Pencil*, then turn the Globe, till the Degree opposite to the Sun's Place be elevated 18 Degrees in the *Quadrant of Altitude* above the *Horizon* in the *West*, so shall the Sun's Place be depressed 18 Degrees below the *Eastern Horizon*, and the Hour-Index will point out the Hour that the Morning-Twilight begins, which subtract from the Time of Sun-rising, the Remainder is the Continuation of the Morning Twilight. Then for the Evening-Twilight,

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Twilight, after the Globe is rectified by *Prob. III.* bring the Degree of the Sun's Place 18 Degrees above the *East-side* of the *Horizon*, measured on the *Quadrant of Altitude*, then will the Sun's Place be depressed 18 Degrees below the *Western-side* of the *Horizon*, the Index will point out the Time of Sun-setting, from the ending of the Evening-Twilight; the Remainder will be the Continuation of the Evening-Twilight.

PROBLEM XXI.

A Place being given on the Globe, to find its Bearing from any other Place.

Bring the given Place to the brazen *Meridian*, and elevate the *Pole* according to its *Latitude*, and fixing the *Quadrant of Altitude* in the *Zenith*, apply the same successively to any of the Places whose Bearing is desired; the *Quadrant* will intersect the wooden *Horizon* at those various Points of the *Compass*, upon which those Places bear in respect of the given Place.

PROBLEM XXII.

A Place being given on the Globe, to find all other Places that are situated from the same upon any desired Point of the Compass.

Elevate the *Pole* according to the *Latitude* of the given Place, bring the said Place to the
brazen

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brazen *Meridian*, and fix the *Quadrant* of *Altitude* in the *Zenith*; apply the *Quadrant* to the desired Point of the Compass upon the wooden *Horizon*, and observe what Places are under the graduated Edge of the said *Quadrant*, for those are the Places desired.

P R O B L E M XXIII.

The Day, and Hour of the Day being given, to find, 1. Those Places on the Globe, in which the Sun then riseth. 2. Those in which he then setteth. 3. Those in which it's Mid-day. And Lastly, Those Places that are actually enlightened, and those that are not.

Find that Place of the Globe, to which the Sun is vertical at the given Time, by *Prob. XIII.* and bring the same to the brazen *Meridian*, and elevate the *Pole* according to the *Latitude* of the said Place. The Globe being fixed in that Position, observe what Places are in the *Western Semi-circle* of the *Horizon*, for in them the Sun riseth at that Time. 2. Those in the *Eastern Semi-Circle*, for in them the Sun setteth. 3. Those that are exactly under the brazen *Meridian*, for in them it's *Mid-day*. And Lastly, All those upon the upper *Hemisphere* of the Globe, for they are actually enlightened, and those upon the lower are in *Darkness*, or deprived of the Sun at that very Time.

P R O B L E M

P R O B L E M XXIV.

The Day and Hour of either a Solar or Lunar Eclipse being known, to find by the Globe all those Places, in which the same will be visible.

Mark the Sun's Place in the *Ecliptick* for the given Day, as also the opposite Point thereto, which is the Place of the Moon at that Time. Then find that Place of the Globe to which the Sun is vertical at the given Hour, by *Prob. XIII.* and bring the same to the *Zenith* (or the Vertical Point) of the wooden Horizon, and fixing the Globe in that Situation, observe what Places are in the upper *Hemisphere*, for in most of them will the Sun be visible, during the Time of the *Eclipse*. As for the *Lunar Eclipse*, you are to find the *Antipodes* of that Place, which hath the Sun Vertical at the given Hour, and bringing the same to the Pole of the wooden *Horizon*, observe what Places are in the upper *Hemisphere* of the Globe, for in such will the Moon be visible during her *Eclipse*, except those near, or in the Horizon.

P R O B L E M

P R O B L E M XXV.

The Hour of the Day being given, according to our Way of Reckoning in England, to find thereby the Babylonick Hour at any Time.

The *Babylonick Hour* is the Number of Hours from Sun-rising, it being the Manner of the *Babylonians* of old, and the Inhabitants of *Norimberg* at this Day, to commence their Hours from the Appearance of the Sun in the *Eastern Horizon*. For the finding of this Hour at any Time or in any Place: First, elevate the Pole to the Latitude of the given Place, and mark the Sun's Place in the Ecliptick at that Time, bring the same to the brazen Meridian, and set the Index of the Hourly-Circle at Noon; then move the Globe either Eastward or Westward, according to the Time of the Day, till the Index point at the given Hour. Then fix the Globe in that Position, and bring back the *Index* again to Noon, and move the Globe from West to East, 'till the Sun's Place mark'd in the Ecliptick, coincide with the *Eastern Horizon*, which done, reckon upon the Hour Circle, the Number of Hours between the Index and Noon, (or the upper Figure of 12.) for that is the Number of Hours, from Sun-rising for that Day, in the given Place, or the true *Babylonick Hour* desired.

P R O B L E M

P R O B L E M XXVI.

The Babylonick Hour being given, to find the Hour of the Day at any Time, according to our Way of Reckoning in England.

Elevate the Pole to the Latitude of the given Place, and marking the Sun's Place in the *Ecliptick*, bring the same to the brazen *Meridian*, and set the *Index* of the *Horary-Circle* at Noon. Then move the Globe *Westward*, till the *Index* point at the given Hour from Sun-rising, and fixing the Globe in that Situation, bring the *Index* back again to Noon, and turn the Globe backwards, till the Sun's Place mark'd in the *Ecliptick*, return to the same Semicircle of the brazen *Meridian* from whence it came; which done, observe what Hour the *Index* of the *Horary-Circle* pointeth at, for the same is the Hour desir'd.

P R O B L E M XXVII.

The Hour of the Day being given, according to our Way of Reckoning in England, to find thereby the Italicke Hour at any Time.

The *Italicke Hour* is the Number of Hours from Sun-setting at all Times of the Year, to Sun-setting the next following Day. For finding of which, elevate the Pole according to the Latitude of the Place, and noting the Sun's
Place

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Place in the *Ecliptic* for the given Day, bring the same to the brazen *Meridian*, and set the *Index* of the Horary Circle at Noon, then turn the Globe either *East* or *West*, according to the Time of the Day, till the *Index* point at the given Hour, and fixing the Globe in that Position, bring the *Index* back to Noon: Which done, turn the Globe *Eastwards*, till the Mark of the Sun's Place in the *Ecliptic* coincide with the *Western* Horizon, and observe how many Hours are between the upper Figure of 12 and the *Index*, (reckoning from *Eastward* as the Globe moved) for these are the Hours from Sun-set, or the *Italick Hour* desired.

P R O B L E M XXVIII.

The Italick Hour being given, to find thereby the Hour of the Day at any Time, according to our Way of Reckoning in England.

Elevate the Pole to the *Latitude* of the given Place, and mark the Sun's Place in the *Ecliptic*; bring the same to the *Western Horizon*, and setting the *Index* of the Horary Circle at Noon, turn the Globe *Westward*, till the *Index* point at the *Italick Hour* given; then fixing the Globe in that Position, bring the *Index* back to Noon, and move the Globe *Eastward*, till the Mark of the Sun's Place come to the *East* Side of the brazen *Meridian*. Which done, observe how many Hours are between

I Noon

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Noon and the *Index* (reckoning them from *West* to *East*) for those are the Hours desired, according to our Way of Reckoning in *England*.

P R O B L E M XXIX.

The Hour and Day being given, according to our Way of Reckoning in England, to find thereby the Judaical Hour at any Time.

The *Jews*, in Reckoning their Time, divide the artificial Day into 12 Hours, and the Night into as many, which Hours prove every Day unequal in Extent (unless in Places exactly under the *Equator*) they still increasing or decreasing according to the Seasons of the Year, or the various Declination of the Sun.

For the finding of which Hours, observe the following Method: Elevate the *Pole* according to the *Latitude* of the given Place, and marking the Sun's Place in the *Ecliptick* at that Time, bring it to the *Eastern Horizon*, and set the *Index* of the Horary-Circle at Noon; then turn the Globe about, till that Place marked in the *Ecliptick* come to the *Western Horizon*, and observe the Number of Hours between Noon and the *Index*, these being the Hours of which the given Day doth consist, which Number you are to take Notice of, and to find what Hour from Sun-rising corresponds with the given Hour, or from
Sun-setting,

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Sun-setting, if the given Hour be after Sun-setting. Which done, work by the following Proportion. As the Number of Hours, whereof the given Day consisteth (*viz.* those set down) is to 12; So is the Number of Hours from Sun-rising (if it be an Hour of the Day) or from Sun-setting (if an Hour of the Night) to a Fourth Proportional, which is the Number desir'd, *viz.* the *Judaical Hour* at the Time given.

P R O B L E M XXX.

The Judaical Hour being given, to find thereby the Hour of the Day at any Time, according to our Way of Reckoning in England.

Elevate the *Pole* according to the *Latitude* of the given Place, and finding the Sun's Place in the *Ecliptick* at the given Time, bring the same to the *Eastern Horizon*, and set the *Index* of the *Horary Circle* at Noon, then turn the Globe *Westward*, till the Sun's Place coincide with the *Western Horizon*, and the *Index* will point at the Number of equal Hours whereof that Day consisteth, which Number you are to write down, and bring the Sun's Place to the brazen *Meridian*, and setting the *Index* again at Noon, turn the Globe about till the Sun's Place coincide with the *Eastern Horizon*, and the *Index* will point at the Hour of Sun-rising in the given Place. Which done, work by the following Proportion : As 12 is to the

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given

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given Number of *Judaical Hours*; So is the Length of the Day in equal Hours (formerly found out) to a Fourth Proportional, which is the Number desired, *viz.* The Hour of the Day, according to our Way of Reckoning in *England*. Only Note, That if the Fourth Proportional be less than 12, you are to add the same Number of Hours before Noon for that Day, but if it be more than 12, subtract it from 12, and the Remainder will give the Hour of the Day for the Afternoon.



S E C T. VIII.

Containing a Description of the CELESTIAL GLOBE.

IN the vast indefinite Space of the Universe appear the *Celestial Lights*, which are either fixed, as the *Stars*, or errattick as the *Planets*.

The fixed Stars are so called, because they always keep the same invariable Distance from one another, as so many *lucid Bodies* or *Suns* in the Concavity of the *Heavens*.

Those Stars that are nearest to us, seem far to exceed others in apparent Magnitude and Brightness: Hence arises the Distribution of
Stars,

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Stars, according to their Order and Dignity, into Classes.

The first Class, containing those which are nearest us, are called *Stars* of the first *Magnitude*, because they appear the greatest and most bright.

Those that are next to them, are Stars of the second *Magnitude*, and so on till we come to Stars of the sixth *Magnitude*, which comprehends the smallest Stars that can be discerned with the naked Eye ; for all the other Stars, which are only seen by the Help of Telescopes, are not reckon'd among these six Orders.

The *Ancients* divided the fixed *Stars*, visible in our *Temperate Zone*, into 48 *Constellations*, 12 of which are situate along the *Zodiack*, giving Names to the 12 Signs, or the Portions into which the *Zodiack* is divided.

In the *Northern* half of the *Zodiack* there are *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo* and *Virgo*. In the *Southern*, *Libra*, *Scorpio*, *Sagittarius*, *Capricornus*, *Aquarius* and *Pisces*.

The other Images are considered in respect of their lying either in the *North* or *South* Side of the *Zodiack*. In the *Northern* Region are 21 *Constellations*, viz. the lesser *Bear*, the great *Bear*, the *Dragon*, *Cepheus*, *Bootes*, the *Northern Crown*, *Hercules*, the *Harp*, the *Swan*, *Cassiopeia*, *Perseus*, *Andromeda*, the *Triangle*, *Auriga*, *Pegasus*, *Equiculus*, the *Dolphin*, the *Arrow*, the *Eagle*, *Serpentarius* and the Ser-

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pent. To these were afterwards added the Constellations of *Antinous*, made out of the unformed ones near *Aquila*, and of *Berenice's Hair*, consisting of *Stars* near the *Lyon's Tail*.

On the *South Side* of the *Zodiack* there are 15 Constellations, which were known to the Ancients, *viz.* The *Whale*, the *River*, the *Hare*, *Orion*, the *Great Dog*, the *Lesser Dog*, the *Ship*, the *Hydra*, the *Cup*, the *Crow*, the *Centaur*, the *Wolf*, the *Altar*, the *Southern Crown*, and the *Southern Fish*. To these are lately added 12 more Constellations that are invisible to us, being near the *South Pole*; namely, the *Phoenix*, the *Crane*, the *Peacock*, the *Indian*, the *Bird of Paradise*, the *Southern Triangle*, the *Fly*, the *Cameleon*, the *Flying Fish*, the *American Goose*, the *Water Serpent*, and the *Sword Fish*.

Without the *Compass* of the *Constellations*, there are several *Stars* which cannot be reduced to any of the preceding *Constellations*, and these are called unformed *Stars*, out of which *Astronomers* have made new *Constellations*, as *Charles's Heart*, and *Sobiesky's Shield*.

The *Milky Way* comes under this Head of *Constellations*, for the modern *Astronomers* have found it to be a Collection of innumerable little fixed *Stars*; it's a broad Circle, white like Milk, compassing the whole *Heavens*, sometimes in a double, but generally in a single *Path*. The Portion of the *Heavens*, which this Circle passes through, is every
Way

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Way fill'd with an infinite Multitude of small Stars ; which, though they are not perceptible to the naked Eye, by reason of their exceeding Smallness, yet by their Light they illustrate that Part of the *Heavens* to which they belong.

There are also two little Clouds situated near the South *Pole*, somewhat resembling the *Milky-way*, but invisible in *Europe*, and called by the Sailors the *Magellanick Clouds* : Dr. *Halley* assures us, that they are exactly of the Whiteness of the *Milky-way*, and being viewed by a *Telescope*, they present us here and there with little *Nebulæ* and small *Stars*. The greater of these two is situated between *Hydrus* and *Dorado* ; and the lesser between *Toucan* and *Hydrus*.

By the Help of *Constellations*, the ancient *Astronomers* have digested the *Stars* into Catalogues which they have delivered down to Posterity : These Catalogues have been much increased and corrected by our modern *Astronomers*, of which the most compleat is to be expected from the Labours of that most excellent Observer Dr. *Halley*, Royal Professor of *Astronomy* at *Greenwich*. The Number of *Stars* inserted in this Catalogue are 3000, of which there are many that cannot be seen without a *Telescope*.

The fixed *Stars* are Bodies of a fiery Nature, as our *Sun* is ; that is, they shine with their own Light ; for the native Light that these fiery and flaming Bodies send forth, is

stronger and more piercing, and acts upon the nervous Fibres of the *Retina*, with a greater Force than the Light reflected from *Opake* Objects, for all Light is much weakened by Reflection.

It is reasonable to suppose that these fixed *Stars* are *Suns* at great Distances from one another, each of which is surrounded with a Chorus of *Planets* peculiar to it self, which in different Periods and Distances perform their Circulations round their proper *Sun*; every *Sun* doing the same Office to his proper *Planets* in illustrating, warming and cherishing them, that our *Sun* performs to the System to which we belong.

Now, though the fixed Stars seen from the Sun do always preserve the same *Distances*, *Positions*, and *Situations*, in respect of one another, yet in respect of the Eye we observe them to change their *Positions*, and sometimes they seem to mount higher in the *Heavens*, and to come more perpendicularly over us; then they descend again, and appear to turn round in Circles, some in greater, some in less, about an Axis, which is the Axis of the Earth; so that in 24 Hours they seem to revolve about the Earth from East to West, which apparent Motion of the Heaven is occasioned by our Earth turning about its own Axis daily from West to East, by which the Systems of the Stars, both fix'd and erratick, with all the Furniture of the Heavens, seem to have a Motion from East to West, which is call'd
the

the *Diurnal Motion* of the Heavens, and by the Ancients was believ'd to be real, but the Moderns have discover'd that 'tis only apparent, arising from the simple Motion of the Earth round its Axis in 24 Hours: For seeing our Eye cannot perceive its own Motion, because turned round with the Earth, it cannot well be but that it should possess the Mind at first with a Notion against the Motion of the Earth, tho' it be, indeed moved, and at first ascribe the diverse Positions of the Stars, which arise from the *Diurnal Motion* of our own Globe, to another Cause than the true one, that is, to the Motion of the heavenly Bodies themselves. *We sail from the Port while the Lands and the Cities seem to recede from us*, at least so far for certain is known, all the Phænomena of the *Primum Mobile*, as it was called of old, may be deduced from the Motion of the Earth about its own *Axis*, without the least Circumvolution of the Heavens. Moreover, it is no less certain from the late Observations of Astronomers, that very many of the rest of the heavenly Bodies are in like manner turned continually about their own Axis, and that those Bodies are neither less than our Earth, nor seem in their own Nature more fitted for such a Rotation. What hinders therefore, but that we should free the Heavens from that superfluous Labour, and attribute the same *Diurnal Motion* to the Earth it self? The Sun, the Prince of our System, and of his planetary Attendants, not a few, as is now found

found out for certain, revolve about their own Axis: the Times also of their Revolutions differ not much from that Revolution we are treating of; that Motion therefore, even from mere Conjecture, and a Comparison made of it, with its fellow Bodies, is with very much Probability attributed to the Earth.

Since the Earth turns so round the Sun that its Axis remains parallel to itself, it seems necessary that this Axis, at different Seasons of the Year, should point to different *fixed Stars*, and that the *Star* or Point of the Heavens, which is directly over the Pole of the Earth in the Summer, should not be directly over it in the Winter, but that the Axis should point to another *Star*, whose Distance from the former should be equal to the Distance of the whole Diameter of the *Earth's* Orbit.

For let ABCD be the Orbit of the Earth, in whose Center is the Sun S; AB the Diameter of the Orbit: When the Earth is at A, its *Axis* is directed to the *Star* E, which is directly over the *Pole* of the *Earth*: Now when the Earth comes to the opposite Point of the Orbit B, the *Axis* being in a Position parallel to its former Position, will no longer Point to the *Star* E but to another *Star* F, which two *Stars* will be distant from each other the whole Length of the Diameter of the great Orbit, but the angular or observable Distance of the *Stars* is the Angle EBF, which is equal to the Angle AEB, by the 29th Proposition of the first Book of *Euclid*,

But

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But the Angle AEB is the Angle under which the Diameter of the great Orbit, or Orbit of the *Earth*, is seen, from the Star E, which Angle EBF or AFB, is called the *Parallax of the great Orbit*, and if it could be observ'd, we might by it find the Distance of the *Star E* from the *Earth*, in respect of the *Sun's* Distance from us: For in the Triangle EAD, we have the Angle E, which is equal to the Angle EBF, which we suppose we can observe: We have likewise the Angle EAB, which, in the *Equinoctial Point*, is always a right Angle; and in the *Solstices*, it is equal to the Inclination of the *Earth's Axis* to the Plane of the *Ecliptick*, and is always equal to the visible Distance of the *Sun*: From the *Pole* hence in this Triangle we have all the Angles; we have likewise the Side AB, and consequently by *Trigonometry* we can find the Side AE, or EB, the Distance of the *Star E* from the *Earth*.

But the Truth is, that the Distance of the Stars is so great, in respect of AB, that the Angle EBF, is so very small, that there can be no Instrument made nice enough to observe it exactly, and they that have taken most Pains to find it out, could never observe it to be so great as one Minute; and since, in the Observations of such small Angles, Errors are scarcely to be avoided, and such too as will, in the Computation, produce prodigious Differences in the Distances which depend upon them; we cannot trust such Observations :

tions : For if, with Mr. *Flamsteed*, we should suppose, the Parallax, or the Angle *EBF*, to be 42 Seconds, and there be an Error committed in Observation, which makes the Angle 25 Seconds bigger than it really is, (and no Man can be sure that he has not committed an Error) the Distance of the fixed *Stars*, in that Case, will really be double to what our Observation makes it : But if the Observations happen to be less accurate, so that there may be a Minute or more between them and the Truth (and most of our Observations are such) the Distance that ariseth from the Computations, made on such Observations, will be prodigiously wide of one another, and all of them will be very different from the Truth.

Besides the apparent Diurnal Motion of the *Heavens* from *East* to *West*, the fixed *Stars* seem to have another Motion, whereby they seem to move very slowly from *West* to *East*, or according to the Order of the Signs ; this Motion is so very slow, that it is computed to require 25920 Years for the fixed *Stars* to be carried thereby through the twelve Signs : But this *Phænomenon* of the fixed *Stars* arises from the Precession of the *Equinox*, by which they are carried constantly back into the preceding Signs, and fall more and more behind the succeeding *Stars*.

The Intersections moving *Westward*, the *Stars* will seem to remove more and more *Eastward* in respect of the *Equinoctial* Points, and therefore the *Longitude* of the *Stars*, which

which are computed from the first Point of *Aries*, or the Vernal Interfection of the *Equator* and *Ecliptick*, must constantly increase, and all the *Stars* will seem to have a Motion *Eastward*; not that they have really any such Motion, but because the *Equinoctial* Points have a contrary Motion to the *West*, so that the Distances of the *Stars*, or their *Longitude* from the first Point of *Aries*, reckon'd *Eastwards*, becomes constantly greater about 50 Seconds each Year. Hence it is that all the *Constellations* have changed their Places; thus, the *Constellation* of *Aries*, that in *Hipparchus's* Time, was near the Vernal *Equinox*, is now removed a whole *Sign* towards the *East*, and is got into the Sign or Portion of the *Ecliptick* called *Taurus*, and so every *Constellation*, has, since the first Observation, changed Place with the following: But the Portions of the *Ecliptick* retain still the same Names which they had in the Time of *Hipparchus*.

But as the Diurnal *Phænomena* of all the *Celestial* Bodies arise from the simple Motion of the *Earth* about its *Axis*; so this apparent Motion of the *Stars*, forward in the *Ecliptick*, ariseth from the Motion of the *Equinoxes*, by which they are carried constantly back into the preceding *Signs* or *Stars*, and fall more and more behind the succeeding ones; the *Physical* Cause of which was discovered by the incomparable Sir *Isaac Newton*, to arise according

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according to the Laws of Motion and Gravity from the broad Spheroidical Figure of the *Earth*, and that this broad Spheroidical Figure arises from the Rotation of the *Earth* round its *Axis*.

The fixed Stars are represented on the *Celestial Globe*: For the understanding of which, observe the following *Definitions*.

DEFINITIONS and PROBLEMS for the Celestial Globe.

AL L Circles describ'd on the *Terrestrial Globe*, are also Circles on the *Celestial*. As on the *Terraqueous Globe*, all the *Meridians* described, meet in the *Poles* of the *Equator*, so on the *Celestial*, all the Circles of *Longitude* drawn through the 12 *Signs*, meet in the *Poles* of the *Ecliptick*.

Def. I. Declination of the *Sun* and *Stars* is their Distance from the *Equator*, number'd on a *Meridian*; therefore Parallels to the *Equator* are Parallels of *Declination*.

Def. II. *Amplitude* is the Distance of the Rising or Setting *Sun* or *Star* from the *East* or *West* Point of the *Horizon*; it is either *Ortive*, when the *Star* rises, or *Occidual*, when it sets.

Def. III.

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Def. III. Right Ascension of the *Sun* or any *Star*, is that Degree of the *Equinoctial* accounted from the Beginning of *Aries*, which cometh to the *Meridian* with the *Sun*, or *Star*, or with any Point in the Heavens.

Def. IV. Oblique Ascension is that Degree and Minute of the *Equator* that is rising above the *Horizon* when the *Sun* or *Star* is rising in an Oblique Sphere. And *Oblique Descension* is that Degree of the *Equator* which is at the *West Side* of the *Horizon*, when the *Sun* or *Star* is setting in an Oblique Sphere.

Def. V. Ascensional Difference is the Difference betwixt the *Right* and *Oblique Ascension*: If the *Latitude* of the Place, and Declination of the *Sun* or *Star* be towards the same *Pole*, viz. both *North*, or both *South*, the *Right Ascension* is the greatest, and on the contrary.

Def. V. Longitude of the Sun, Star, or any other *Celestial Phænomenon*, is an Arch of the *Ecliptick*, contained between the first Point of *Aries*, and the Point whose *Longitude* is required.

But because the *Ecliptick* is divided into 12 *Signs*, the *Longitude* of a *Star* is therefore (in the most customary Account) an Arch of the *Ecliptick*, comprehended between the Semicircle of *Longitude* passing thro' the Beginning of *Aries*, and the Semicircle of *Longitude*

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tude passing thro' that Degree of the Sign the Star is in.

Def. VI. The *Latitude* of a Star is an Arch of a Semicircle of *Longitude*, comprehended between the *Ecliptick* and *Star*: And is either *North* or *South*, according as the *Star* is on the *North* or *South* Side of the *Ecliptick*.

Def. VII. *Azimuth* is the Distance betwixt the *North* Point of the *Horizon*, and that Point where a Vertical Circle passing through the Body of the Sun or Star, cuts the *Horizon*, or the Distance betwixt the *Prime Vertical*, and the *Vertical* the Sun or Star is upon.

Def. VIII. *Altitude* of the Sun or Star, is an Arch of an *Azimuth* Circle comprehended between the *Horizon* and the Parallel of *Altitude* the Sun or Star is upon.

Def. IX. The Sun, or any Star, is said to rise, when they come to the *East* Side of the *Horizon*, and to set when it comes to the *West* Side of the *Horizon*.

The Poets have a threefold Rising of the Stars, viz. *Cosmic*, *Acronic*, and *Heliac*.

Def. X. A Star is said to rise *Cosmically*, which rises or sets, when the Sun riseth. So that a Star that riseth or setteth in the Morning, rises or sets *Cosmically*.

Def. XI.

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Def. XI. A Star rises *Acronically*, if it rise when the Sun sets, that is in the Evening, when it is in Opposition to the Sun, and is visible at Night.

Def. XII. A Star rises *Heliacally*, when after it has been in Conjunction with the Sun, it comes to be at such a Distance from him, as to be seen in the Morning before Sun-rising.

But the *Heliac* Setting is when the Sun approaches so near a Star that he hides it with his Beams, which keeps the fainter Light of the Star from being perceived.

PROBLEM I.

To represent the Face or Appearance of the Heavens, or to shew the Situation of the fixed Stars for any Hour of the Night.

Rectify the *Globe* to the *Latitude* of the Place; bring the Sun's Place to the *Meridian*, and the *Index* to Noon, set the *Globe* by the Needle, that its *Cardinal Points* agree with the *Cardinal Points* of the Compass, turn the *Globe* till the *Index* point at the given Hour, and observe what Stars were at or near the *Meridian*, or any other Point of the Compass, for those will appear upon the same Points of the Compass in the Heavens.

Hence it is obvious, that this *Problem* is of good Use to know the *Constellations* and

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the several remarkable *Stars* in each *Constellation*.

P R O B L E M II.

To find the Longitude and Latitude of any Star.

For the *Longitude*, screw the *Quadrant* of *Altitude* over that *Pole* of the *Ecliptick* which is nearest to the *Star* whose *Longitude* you seek, then lay the *Quadrant* over the *Center* of the *Star*, look what *Degree* of the *Ecliptick* the *Quadrant* crosseth, which *Degree* numbered from *Aries* is the *Star's Longitude*.

For the *Latitude*, the *Quadrant* fitted as before, and laid over the *Center* of the *Star*, then the *Degrees* of the *Quadrant* comprehended between the *Ecliptick* and *Star* is its *Latitude*.

P R O B L E M III.

To find the Right Ascension and Declination of the Sun or Star.

For the *Right Ascension*, the *Globe* being rectified, bring the *Sun* or *Star* to the *Meridian*, and the *Degrees* of the *Equator* contained between the *Beginning* of *Aries* and the *Meridian*, is the *Right Ascension*: The *Sun* or *Star* being at the *Meridian*, the *Degrees* of the same *Meridian* contain'd between the *Equator* and the *Star* is its *Declination*.

P R O -

PROBLEM IV.

To find the Distance of Two Stars.

Apply the *Quadrant* of *Altitude* to the two Stars, the Degrees of the *Quadrant* intercepted between them, is their Distance; if the *Quadrant* be too short, you may take their Distance with a Pair of Compasses, which applied to any graduated great Circle, gives their Distance in Degrees.

PROBLEM V.

To know what Day in the Year any Star shall be upon the Meridian at Twelve a Clock at Night.

Bring the Star to the *Meridian*, and mark what Degree of the *Ecliptick* is at the North *Meridian* under the *Horizon*, and on the *Horizon* find what Day of the Year standeth against it, for that Day of the Year will that Star be upon the South Part of the *Meridian* at 12 a Clock at Night.

PROBLEM VI.

The Sun's Place and Altitude of a known Star being given, to find thereby the Hour of the Night.

The Globe being rectified, bring the Sun's Place to the brazen *Meridian*, and set the

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Index to 12, then move the *Globe* and *Quadrant* of *Altitude* together, till the *Star* meet with its *Altitude* upon the *Quadrant*, and the *Index* will point out the *Hour* of the *Night*.

P R O B L E M VII.

The Month and Day being given, as also the Place of the Moon in the Ecliptick, and her Latitude; to find the Hour of her Rising and Setting, as also the Time of her coming to the Meridian of the given Place.

The *Moon's Place* in the *Zodiack* may be found at any *Time* by an *Ephemeris*. For the *Solution* of this *Problem*, elevate the *Pole* to the *Latitude* of the *Place*, find the *Sun's Place* in the *Ecliptick*, and mark it with *Chalk*, as also the *Moon's Place* at the same *Time*: Bring the *Sun's Place* to the brazen *Meridian*, and set the *Index* of the *Horary-Circle* at *Noon*, and turn the *Globe* till the *Moon's Place* successively coincide with the *Eastern* and *Western Sides* of the *Horizon*, as also the brazen *Meridian*, and the *Index* will point at those various *Times*, the particular *Hour* of her *Rising*, *Setting*, and *Southing*.

PROBLEM VIII.

Any Star being given, to find its Oblique Ascension or Descension, as also its Eastern and Western Amplitude.

Rectify the Globe to the *Latitude* of the Place, and bring the Star to the *Eastern* Part of the *Horizon*, and mark the Degree of the *Equator* that ascends with it, for the Arch of the *Equator* intercepted between the Beginning of *Aries* and the Point thus marked, is the *Oblique Ascension* of the Star.

And the Arch of the *Horizon* intercepted between the *East* and the Place of the Star, is the *Eastern Amplitude* of the Star: And if you bring the Star to the *Western* Side of the *Horizon*, the Degree of the *Equator* then descending will be the *Oblique Descension*; and the Arch of the *Horizon* intercepted between the *West* Point of the *Horizon* and the Star, will be its *Western Amplitude*.

PROBLEM IX.

To know by the Globe at what Hour any known Star cometh upon the Meridian for any Day in the Year, as also the Time of its Rising and Setting.

Rectify the Globe to the *Latitude* of the Place, bring the Sun's Place (for the given

Day) to the brazen *Meridian*, and set the *Index* to Noon, then turn the Globe till the Star come to the *Meridian*, as also the *Eastern* and *Western* Side of the *Horizon*, and the *Index* will point at those various Times, the Hours of the Star's *Rising*, *Setting*, and *Southing*.



SECT. IX.

Of the SOLAR SYSTEM.

BESIDES the fixed *Stars* described in the foregoing *Section*, there are other shining Bodies to be observed, which perform their *Revolutions* round the *Sun* in very different Periods of Time, and therefore they must have constantly variable Positions, and be always changing their Distances from one another, as well as from the fixed *Stars*: These *Globes* or *Stars* are called *Planets* or *Wanderers*, and are divided into *Primary* and *Secondary*.

The *Primary Planets* are in Number six, and describe their *Orbits* about the *Sun* from *West* to *East*, in the following Order: *viz.*

1 *Mercury*

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♂ *Mercury* next the *Sun*, in 87 Days,

♀ *Venus* in 224 Days 17 Hours.

⊕ The *Earth*, in 365 Days, 5 Hours, and 49 Minutes.

♂ *Mars*, in 687 Days.

♃ *Jupiter*, in 4332 Days, 12 Hours, that is almost 12 Years.

♄ *Saturn*, the farthest distant of all the Planets, in 10759 Days, that is near 30 Years.

Their Distances from the *Sun* are nearly in this following Proportion: That is, Supposing the Distance of the *Earth* from the *Sun* to be divided into ten equal Parts, the Distance of *Mercury* will be about four of those Parts; that of *Venus* seven; of *Mars* fifteen, of *Jupiter* fifty two; and that of *Saturn* ninety five.

Three of the *Primary Planets*, viz. the *Earth*, *Jupiter*, and *Saturn*, have *Satellites*, or other Planets revolving about them, hence called *Secondary Planets*. The *Earth* has one, viz. the *Moon*, completing its Revolution in 27 Days 7 Hours, and distant about 60 Semi-diameters of the *Earth* from it.

Jupiter has 4 *Satellites* who attend him; that which is next to him, is no further removed than $2 \frac{5}{6}$ of his Diameter, and turns round him in one Day; $18 \frac{1}{2}$ Hours. The second revolves at the Distance of $4 \frac{1}{2}$ Diameters, in 3 Days 13 Hours. The third at the Distance of 7 Diameters, revolves about him in 7 Days 4 Hours. The fourth at the Di-

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stance of 12 Diameters of *Jupiter*, compleats his Period in 16 Days 16 $\frac{1}{2}$ Hours.

Saturn has five Attendants or *Satellites*, the nearest compleats its Revolution in 1 $\frac{7}{8}$ Days, and its Distance from *Saturn's* Center is 4 $\frac{3}{8}$ of his Semidiameter. The second revolves about *Saturn* in 2 Days 17 Hours, at the Distance of 5 $\frac{3}{4}$ Semidiameter of *Saturn*. The third in 4 Days 12 Hours, who finishes his Revolution at the Distance of 8 Semidiameters. The fourth compleats its Period in 16 Days, and is distant from *Saturn* 18 of his Semidiameters. The fifth and outermost that has been discovered, revolves about *Saturn* in 79 $\frac{1}{3}$ Days, at the Distance of 54 Semidiameters from the Center of *Saturn*.

Besides these Attendants, *Saturn* has an Ornament peculiar to himself, for he is dignified with a Ring, which surrounds his Middle, and does no where touch his Body, but is like an Orbicular Arch, built round him; it is *Opaque*, like a *Planet*, and from the various Positions of it, in respect of the *Sun*, illuminating it, and the Situation of the Observer, the various *Phases* of the Ring of *Saturn* arise. The Diameter of the Ring is to that of *Saturn* as 9 to 4, and the Breadth of the Space between the *Ring* and the Body of *Saturn* is equal to the Breadth of the *Ring* itself.

There are another Sort of Bodies which revolve about our Sun, viz. the *Comets*, which may be look'd upon as *Planets*.

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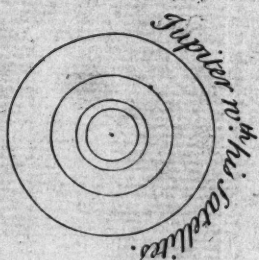
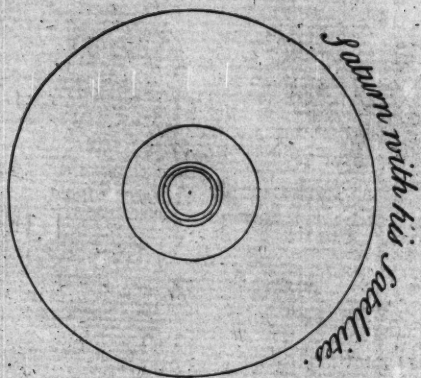
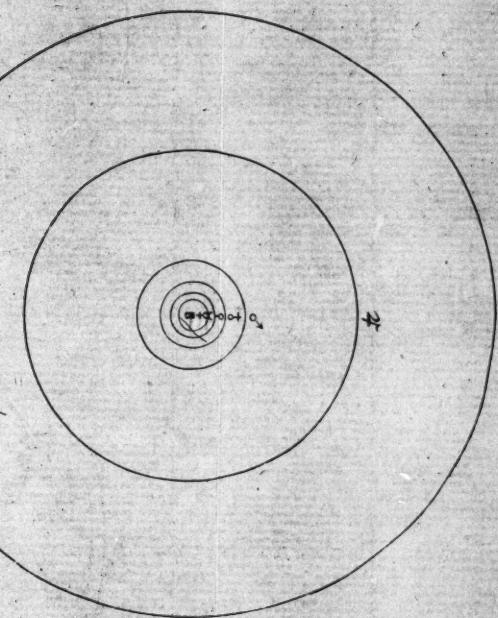


Plate 2 d

Fig. 1.



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The Figures of *Comets* are very different, for some throw Beams every Way round them, and they are called *Hairy Comets*, others again have a fiery Tail, opposite to the Region in which the Sun is seen, and they are called *Bearded*, or *Comets* with Tails. Their Magnitudes have also been observed to be very different, many of them without their Hair (as it is call'd) appearing no bigger than Stars of the first Magnitude : But some Authors have given us an Account of others which were much greater.

Several *Philosophers* and *Astronomers* have maintained that the Motion of the Comets is Rectilinear ; but that which answers best to their Appearances, is a Motion in a *Parabolic* or *Elliptical Orbit*, and when they come to the inferior Parts of their Orbits, and descend towards the Sun, or just ascending from him, then only they become visible, afterwards ascending higher in their *Orbits*, they run into far distant Regions, and withdraw themselves from our Sight.

All the *Planets*, *Primary* and *Secondary*, are *Opaque Bodies*, i. e. such as have no Light of their own, but receive and reflect back again all their Light from the Sun, and therefore are accounted as so many Dependants of the Sun, whence the Sun, with those its Dependants makes up what is called the *Solar System*, represented in Fig. 4. Plate 2.

The *Planets* in respect of the *Earth* are divided into *superior* and *inferior*. The *superior*

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rior Planets are *Saturn, Jupiter, and Mars,* because they surround the *Orbit* of the *Earth.* *Venus* and *Mercury* are called *inferior,* because contained within the *Orbit* of the *Earth.*



S E C T. X.

To describe the Phænomena arising from the Motion of the Earth, and Primary Planets.

TH E Motions of the *Planets,* both *superior* and *inferior,* are regular, according to the Order of the *Signs* of the *Zodiac,* performing their Motions in *Elliptick Orbits* about the Sun; but this Motion appears to the Inhabitants of our Earth very irregular, for they appear at some times to move very swift, according to the Order of the *Signs,* and at other times they seem to move more slow, but still direct: Again, they appear sometimes to have no Motion, continuing to rise and set for several Days with the same fix'd Stars, and then they are said to be *Stationary*; at other times they appear to move contrary to the Order of *Signs,* and then they are said to be *Retrograde*: All which irregular Motions

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Motions of the *Planets*, are natural Consequences of the Motion of the Earth round the Sun; to explain which, let the *Zodiac* be represented by $\gamma, \delta, \pi, \epsilon, &c.$ (Fig. 5. Plate 3.) S the *Sun*, and A B C D the *Orbit* of *Mars*, one of the *superior Planets*, and T represents the *Earth* in its *Orbit* T E X Y; The *Earth* and Planet moving from *West* to *East*, according to the Order of the Signs.

When the Earth is at Y, and the Planet at D, he will appear in Conjunction with the Sun by the Line that points out their Place among the fixed Stars, and in this Case the Sun and Planet will appear to rise and set with the fixed Stars in ϵ , and the Planet will then be in his *Apogee*, or greatest Distance from the Earth, the Earth moving in its *Orbit* from Y to X, while the Planet, which does not move so swift as the Earth, has described the *Arch* D m, the true Motion of the Planet, since his Conjunction with the Sun is the Arch of the *Ecliptick* $\epsilon 4$, but he will appear to an Observer on the Earth, to have run over the Arch $\epsilon 5$, according to the Order of the Signs, which is greater than $\epsilon 4$, wherefore he appears direct and swift in his Motion; the Sun then appears from the Earth among the fixed Stars in the Sign ν , which is farther advanced in the *Ecliptick* than the Planet in m, therefore the Planet appears to rise in the Morning before the Sun. The Earth and Planet advancing in their Orbits, when the Earth shall come to T, if the Planet be at C in his Orbit, he will
appear

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appear opposite to the Sun, and in his *Perigee*, or nearest Distance from the Earth, for when the Planet is in C, he is nearer to the Earth in T, by the Diameter of his annual *Orbit*, than when he appeared from the Earth to be in Conjunction with the Sun. But when the Earth is arrived at O, if *Mars* be in H, he will become *Stationary* in order to his being *Retrograde*; for the *superior Planets* appear *Retrograde* every time the Earth passes between them and the Sun: But since the *Planet* when he appeared from the Earth at X, appeared to move forward according to the Order of the Signs, and afterwards to return backwards between the *progressive* Motion, and *regressive*, there will be a Point where he will appear to stand and continue in the same Situation in the *Heavens*: Now he seems to keep the same Station in the *Heavens*, when a Line that joyns the Center of the Earth and Planet, is constantly directed to the same Point among the fixed Stars.

Thus the Earth being at the Point O, and the Planet in H, he will appear among the fixed Stars at 3, then if the Earth move from O to 7, and in the same Time the Planet move from H to I, he will appear from the Earth with the same fixed Stars at 3, which he appear'd with in H, and all the Time the Earth and Planet were in describing the Arches O 7, and H I in their respective *Orbits*, the Planet continued to rise and set with the same fixed Stars, because the Lines O H and 7 I, joyning the Earth and Planet Centers, are all
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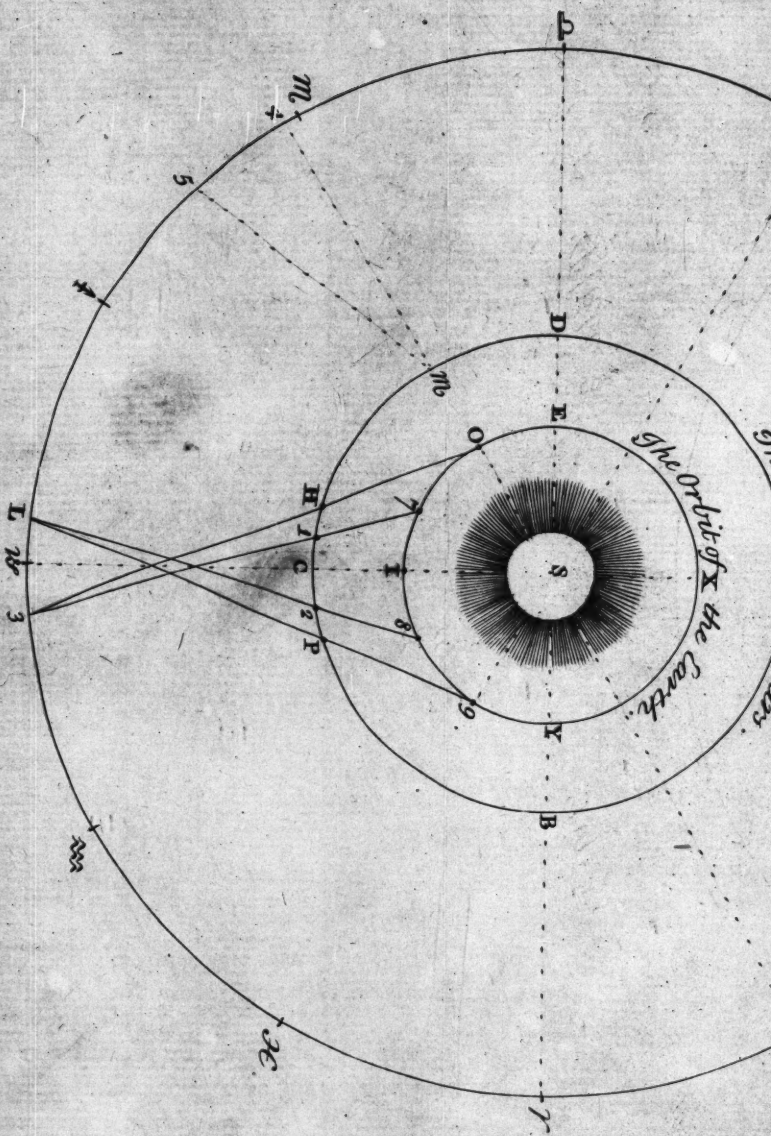
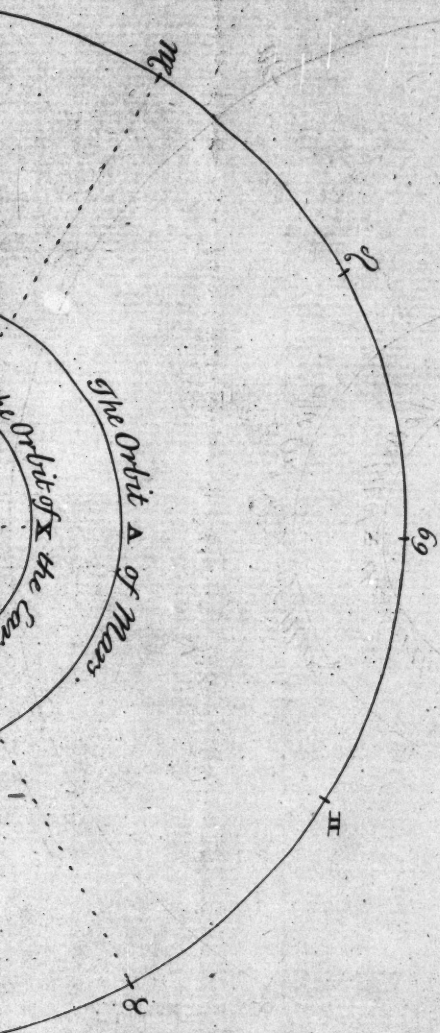


Plate 3. d

Fig. 5.



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that Time directed to the same Point in the *Heavens*, which explains the Station of *Mars*, preceding his *Retrogradation*.

After which, if we suppose the Earth to have moved from 7 to 8, and the Planet from 1 to 2, he shall be seen among the fixed Stars at L, which he more *West* than the Point 3, under which he was seen before, which shews his *Arch of Retrogradation*. Lastly, The Earth having moved from 8 to 9, and at the same Time the Planet from 2 to P, he will appear all that Time with the same fixed Stars in L, which is the second Station, or that which succeeds his *Retrogradation*, whereas in the mean while, if viewed from the Sun, he seemed to move all this Time, as before, in *Consequencia*, or according to the Order of the *Signs*.

These are the apparent *Phænomena* of *Mars* seen from the Earth, and the like *Phænomena* will happen to *Jupiter* and *Saturn*, excepting that *Saturn's Retrogradations* are more frequent than *Jupiter's*, and *Jupiter's* more frequent than that of *Mars*, because the Earth oftner overtakes *Saturn* than *Jupiter*, and *Jupiter* oftner than *Mars*, and passes between them and the Sun.

The *Arch of Retrogradation* appears the greater in Proportion as the Planet is near the Earth; wherefore that of *Mars* is greater than that of *Jupiter*, and the *Arch of Retrogradation* of *Jupiter* greater than that of *Saturn*.

Seeing

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Seeing the *Regress* of the *Planets* depends wholly upon the Situation of the Earth, with respect to the *Sun* and the *Planets*; and seeing, as was said before, the *Regress* is most notable in the very Point of Opposition; it must needs be that the Middle Part of the direct *Motion* should fall in the *Conjunction*; and the Middle Part of the *Regress* in the *Opposition*: and here it is proper to note how strong an Argument for the *Annual Motion* of the Earth, is taken from the *Direction*, *Station*, and *Retrogradation* of the *Planets*, and that upon this Account particularly, that these *Motions* are always observed to respect the Situation of the *Planets* to the *Sun*: For that the Middle *Direction* do happen in the *Conjunction*, and the *Stations* in or about the *Octants*, the Middle *Retrogradations* in the *Oppositions*, and that they always fall thus, and never at other times, is a Thing that neither is nor can be denied. Hear, *Fromondus*, one who was averse enough to the *Annual Motion* of the Earth: "The *Annual Motion* of the Earth, saith he, is maintained by the *Copernicans*, by no Argument more probable and specious than that of the *Station*, *Direction*, and *Retrogradation* of the *Planets*."

From what has been said, it appears that the Earth comes nearer to these *Planets* in the Middle of the *Regressus* than it doth in the Middle of their *Progresses*, by an entire Diameter of the *Orbis Magnus*; wherefore, since the apparent Diameter of any Star is well nigh reciprocally

reciprocally proportional to the Distance of the same; and consequently the apparent *Area* or *Discus* is almost in a duplicate reciprocal Proportion to the Distance; it must necessarily be, that these Planets should appear much greater both in Diameters and Areas, as also in Light and Splendor, in their Oppositions at what Time they are retrograde, than in their Conjunctions with the Sun, when they go forward, and then because the Diameter of the *Magnus Orbis* bears a greater Proportion to the Distance of *Mars* than it doth to that of *Jupiter*, and a greater Proportion to the Distance of *Jupiter* than it doth to that of *Saturn*, it must necessarily obtain a greater Effect in increasing the apparent Magnitude of *Mars* than of *Jupiter*, and of *Jupiter* than of *Saturn*.

Since the *inferior Planets*, *Venus* and *Mercury*, move round the Sun at a less Distance than the Earth, it is evident, that they will always seem to attend the Sun, sometimes to go to the *West* of him, and sometimes to the *East*; this *Digression* to the *East* or *West* is called their *Elongation*, and is measured by an *Arch* of a great *Circle* intercepted between the Planet and the Sun, when a Line, which joins their *Centers*, with the Eye of the Observer on our Earth, is a *Tangent* to their *Orbits*.

The *Elongation* of *Venus* never exceeds 48° , or that of *Mercury* 29° .

When they are at their greatest *Elongation* from the Sun, they will return to the Sun again,

again, and pass as far on the other Side of him, as if their Motions were *Oscillatory*. By which it is plain, that they will, in the Time of their *Revolution* about the Sun, appear twice in *Conjunction* with him; the one *superior*, the other *inferior*. When the Planet is betwixt the Earth and the Sun, it is then in its *inferior Conjunction*, or nearest Distance from the Earth, at which Time, if the Planet be in the *Ecliptick*, that is, in one of its *Nodes*, it will appear as a Spot on the Face of the Sun, and *Retrograde*. When the Sun is directly between the Earth and Planet, it is then in its *superior Conjunction*, appearing from the Earth direct and swift in its Motion, as also in its greatest Distance from the Earth.

To explain the irregular *Phænomena* of *Mercury*, let us suppose, γ , δ , Π , (Fig. 6. Plate 4.) the 4th Part of the *annual Orbit*, which the Sun appears to describe in three Months, in which Time *Mercury* describes his Orbit, 1, 2, 3, 4, 5, about the Sun. If the Earth, in its Orbit is in A, and *Mercury* in 1, it will appear to us in the Sign γ , then if the Earth be advanced to X, and *Mercury* to 2, we shall see him in the Sign δ at the Point B, and while his Motion is from γ to δ , or according to the Order of the Signs, we call it *Direct*; but when the Earth is in E, and *Mercury* in 3, he appears to us still with the same Sign at the Point B, though he has really moved in his Orbit from 2 to 3, and because he rises and

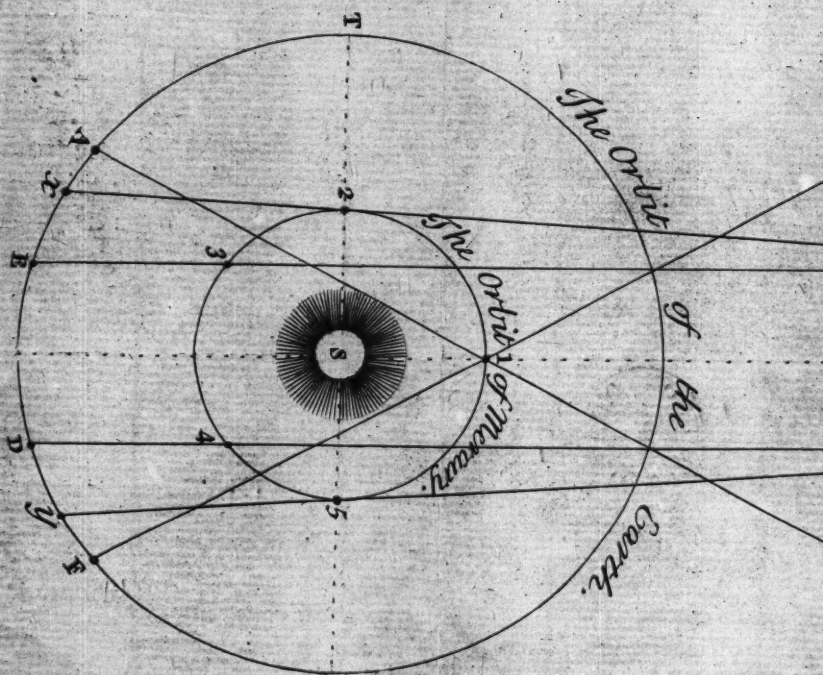
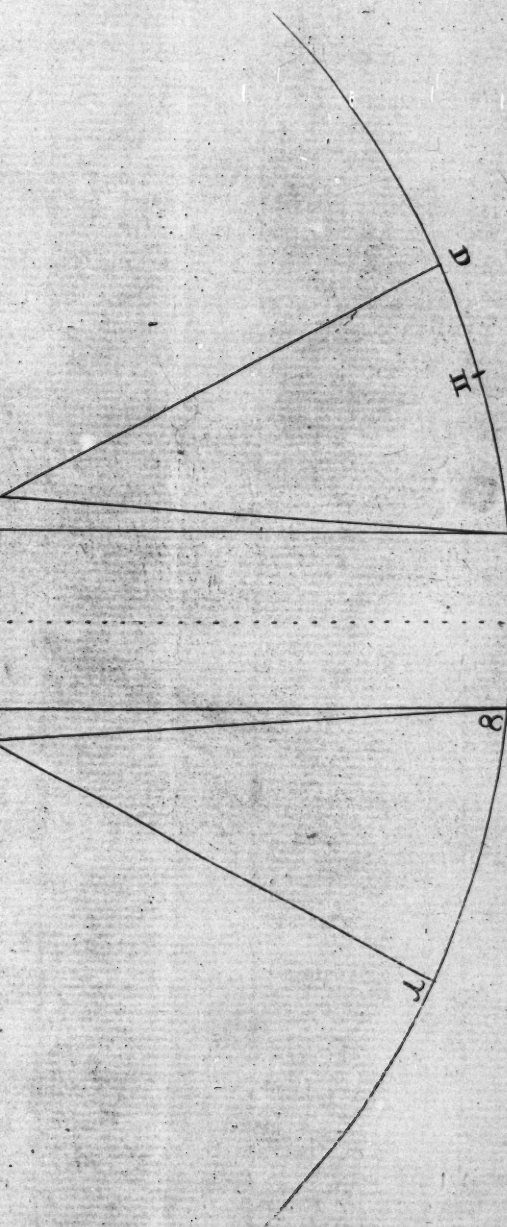


Plate 4th

Fig. 6.



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and sets for some Days with the same fixed Stars, he is said to be *Stationary*, and this Station is that which precedes his *Retrogradation*. When the Earth is advanced to D, and *Mercury* to 4, the Observer will see him from the Earth in the Sign γ at the Point C, and he appears to have gone back, contrary to the Order of the Signs ; therefore he is said to be *Retrograde* : And the *Arch* BC, is the *Arch* of his *Retrogradation*, when he is advanced to 5, and the Earth at Y, he will appear in γ at C, which is his second Station. Lastly, when the Earth is come to F, and *Mercury* to 1, he will appear among the fixed Stars at the Point D, and direct in his Motion.

The apparent Irregularities of the particular Motion of *Venus*, may be explained after the same Manner : Her *Stations* and *Retrogradations* are not so frequent, since she sometimes appears direct for a Year ; because *Mercury* finisheth his Course in a shorter Time, and consequently overtakes the Earth oftner than *Venus*. And since *Mercury's* Orbit is less than that of *Venus*, her greatest *Elongation* must be also less, and she must be a nearer and more constant Attendant of the Sun.



*Of the PHASES and LATITUDE of the
PRIMARY PLANETS.*

Since all the *Planets* are *opaque, spherical Bodies*, reflecting the Rays of Light that fall upon them every Way, it is evident that that Half of each Planet which is exposed or turned to the Sun, is inlightened by it, while the other Half, which is turned from the Sun, is in Darknefs.

And since that Half only which is towards the Earth is seen by the Observer, it is manifest (by Fig. 7. Plate 5.) that when *Venus* is in A, that is most *Retrograde*, and nearest to the Earth at T, she is not visible at all, having her dark Face turned towards us, and if *Venus* were at the same Time in the *Plane* of the *Ecliptick*, that is in one of her Nodes, she would appear like a Spot in the Sun.

When *Venus* is in B, then some Part of the inlightened Half is turned towards the Earth, and because *Venus* is of a *spherical Figure*, and appears like a *Plane*, her inlightened Part will appear horned.

When *Venus* is at C, half the inlightened Part will be seen by an Observer at T; at D she is said to be *Gibbous*, above half the inlightened Part being visible; at E, where she is farthest off, and most direct in her Motion, she appears full, all the inlightened *Hemisphere* being turned towards us at T.

Venus

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Venus will have the same Variety of *Phases* in her Passage thro' F, G and H; that is, she will be *Gibbous* at F, *half full* at G, and *horned* at H.

These Appearances of *Venus*, tho' they are not to be discerned by a naked Eye, yet they are distinctly and plainly to be perceived with a *Telescope*.

The like *Phænomena* will appear in *Mercury*, regard being had to his *Orbit* and *Revolution*.

The superior *Planets*, *Saturn* and *Jupiter*, are also illuminated by the Sun, but that Half of each *Planet* which is turned towards the Sun, that is, the illuminated Half, is likewise turned towards the Earth, because the Earth seen from *Jupiter* or *Saturn* is always to be observed near the Sun's Body, that is near the Center of their Motions; therefore the *Inhabitants* of our *Globe* do always behold these *Planets* shining in full *Orbs*, but the *Orbit* of *Mars* lying very near the Earth, his Face, which is towards the Sun, will not always be turned towards the Earth. Thus, let T (Fig. 7. Plate 5.) represent the Earth in its *Orbit*, it is evident that *Mars* being in M or K, that is in *Conjunction* or *Opposition* to the Sun, has the same Face turned towards the Earth as he has towards the Sun, and consequently appears full; but if *Mars* be in L or I, then some Part of the illuminated Face will be turned from the Earth, and therefore *Mars* will appear *Gibbous*, the Light being a little defi-

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cient towards those Parts that are turned from the Sun.

The Time between two *Conjunctions* of the Sun and *Saturn* seen from the Earth, according to their mean Motions may be found thus:

The Earth, according to its mean Motion, describes an *Arch* of the *Ecliptick* of 59 Minutes 8 Seconds, and *Saturn* moves 2 Minutes in a Day, therefore the Earth will appear from the Sun to recede from *Saturn* 57 Minutes 8 Seconds.

Then say, As 57 Minutes 8 Seconds is to 360 Degrees, So is one Day to a 4th Quantity, which is 378 Days, or one Year and 13 Days, the Time between two *Conjunctions* or *Oppositions* of the Sun and *Saturn*, according to their mean Motions.

By the same Method we find that the Time between two *Conjunctions* or *Oppositions* of the Sun and *Jupiter*, is one Year and 33 Days, and that of *Mars* 2 Years and 50 Days.

The *Ecliptick*, being that Path which the Earth describes about the Sun, or the apparent annual Motion of the Sun about the Earth, is taken by *Astronomers* as the *Standard* to which the *Planes* of the other *Orbits* are judged to incline: And the Right Line, which passes thro' the Sun, and is the common *Section* of the *Plane* of the *Orbit* with the *Plane* of the *Ecliptick*, is call'd the Line of the *Nodes* of that *Planet*, and the Points where the *Orbit* of the *Planet* cuts the *Ecliptick*, are called the *Nodes*.

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Nodes. Thus (Fig. 8. Plate 5.) let TABC be the Plane of the Earth's *Orbit*, infinitely produc'd, NPn the *Orbit*, of any Planet intersecting the Plane of the former *Orbit*, or *Ecliptick*, in N and n, which are the *Nodes* of that *Planet*.

So as that if one Half, NPn, of that *Orbit*, be suppos'd above the Plane of the Scheme, and the other npN, below it, which makes it look like an *Ellipse*, the right Line Nn, joyning the *Nodes*, being the common Section of the Plane of the *Orbit* of the Planet, with the Plane of the *Ecliptick*, is the Line of the *Nodes*.

The Planes of the *Orbits* of the Planets are inclined to the Plane of the *Ecliptick* in the following Manner, viz. the *Orbit* of Saturn makes an Angle $2\frac{1}{2}$ Degrees, *Jupiter* $1\frac{1}{3}$, *Mars* almost 2° , *Venus* about $3\frac{1}{3}$, *Mercury* almost 7° . And these Inclinations are called the *Heliocentrick Latitudes* of the Planets, represented in Fig. 8. by the Angle POL, supposing the Line PL to be perpendicular to the Plane of the *Ecliptick*. And this *Heliocentrick Latitude* will be continually increasing till it come to the Point X, which is called the Limit or utmost Extent of it, and then it will decrease till it come to nothing in n, after which it will increase till it come to p: And lastly, will be decreasing till the Planet come to be in N.

The *Geocentrick Latitude* of the Planets, or their Distance from the *Ecliptick* as they

are seen from the Earth, depends much upon the *Position* and Distance of the Earth: for, where the *Heliocentrick Latitude* continues the same, yet according to the various Positions the Earth may have, the *visible Latitude* of a Planet seen from thence will be various; for, let T t B Fig. 9. be the *Orbit* of the Earth, and δ N n the *Orbit* of the Planet *Mars*; Suppose *Mars* in δ , and the Earth in T, so that δ may be observed in Opposition to the Sun, and from *Mars* let fall, on the Plane of the *Ecliptick*, the Perpendicular δ E, this Line will subtend the Angle δ T E, the *visible Latitude*. But if the Earth was in t, so that *Mars* was seen in *Conjunction* with the Sun, its *visible Latitude* would be the *Arch* which measures the Angle δ t E, which is much less than the Angle δ T E, and nearly in the Proportion as the Distance T δ , is to the Distance t δ .

When the Earth is in T, the *Geocentrick Latitude* of *Mars* is greater than his *Heliocentrick*; but when he is in t, the *Heliocentrick* is greater than the *Geocentrick*; so that according to the various Positions of *Mars* and the Earth, his *visible Latitude* will be changeable, and is greater, the nearer he comes to the Opposition of the Sun, and the less, as he approaches to a *Conjunction* with the same.

To describe the *Phænomena* of the inferior Planets seen from the Earth.

Let T B t represent the Earth's *Orbit*, whose Plane is the same with the *Ecliptick*,
(Fig.

Fig. 7.

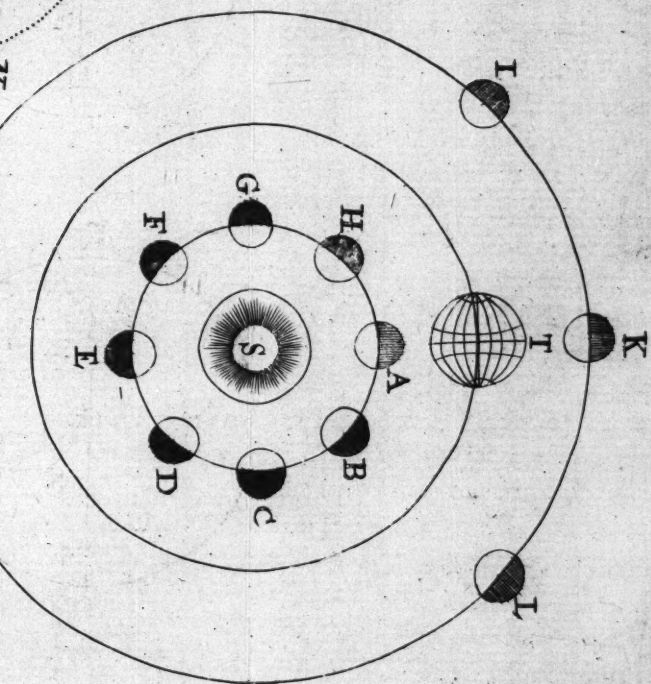
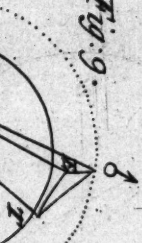


Fig. 9.



(Fig. 10.) and let $N \varphi n$ represent the *Orbit* of an inferior Planet; for Instance, *Venus*, whose Plane is inclined to that of the *Ecliptick*, and therefore will look like an *Ellipse*, whose greater *Axis* is the Interfection of the Planes or Line of the *Noder* Nn , and while *Venus* is in φ , let the Earth be in T ; in which Supposition *Venus* will be nearest the Earth, and *Retrograde*.

It is evident, that the Inclination of the right Line φT to the Plane of the *Ecliptick*, or the *Latitude* of *Venus* in φ , seen from the Earth (which is called the *Geocentrick Latitude*) is measured by the Angle φTE , the right Line φE being made perpendicular to the Plane of the *Ecliptick*. If *Venus* be supposed to continue in φ , and the Earth to be at t , in which Supposition *Venus* is direct, and farthest off the Earth; the *Geocentrick Latitude* of *Venus* will be the Angle φtE , less than φTE , almost in the *Ratio* of $T \varphi$ to $t \varphi$, tho' the *Heliocentrick Latitude* of *Venus* be in both Cases the same.

And what has been now said of *Venus*, is also true in *Mercury*; consequently all other Circumstances being alike, the *Latitude* of the inferior Planets is greater when they are *Retrograde* and nearest the Earth; less, when direct and farthest off.



S E C T. XI.

Of the Phases and Motions of the Secondary Planets.

TH E *Primary Planets* have the Sun which they regard as a *Center* for the *Regulator* of their Motions, but the *Secondary Planets* turn round their respective *Primary Ones* as *Centers*: So the Moon, the Earth's *Satellite*, is kept in our Neighbourhood, by a natural Propension or Gravity towards its *Center*, by Means of which, it is constantly turned out of a rectilinear Course, and is obliged to perform its Revolution round the Earth in 27 Days $7\frac{3}{4}$ Hours: And moves from *West* to *East* the same Way as the Earth does, from A through B C, &c. Fig. 11. Plate 6.

The Plane of the Moon's *Orbit* does not coincide with the Plane of the *Ecliptick*, but is inclined to it by an *Angle* of about 5 Degrees, and the common Intersection of these Planes is the right Line $\alpha\gamma$, the Points $\alpha\gamma$ where the *Orbit* of the Moon intersects the Plane of the *Ecliptick*, are called the *Nodes of the Moon*: So that the *Orbit* of the Moon is to be conceived as Half above and Half below the Plane of the *Ecliptick*, the former $\alpha A \gamma$ to the *North*, and the latter $\alpha A \alpha$ towards the
South,

South, which makes it appear in the Figure of an *Ellipse*.

The Line of the *Nodes* does not always keep the same Position, but is moved backwards, viz. Ω through G F, &c. and ϑ thro' C B, &c. contrary to the Order of the *Signs*, completing a Revolution in about 19 Years, from whence it's certain that the Moon can never be found in the *Ecliptick* above twice in her monthly Course; namely, when she is in the Node Ω or ϑ , all the rest of the Time she is either on the *North* or *South* Side of it, and the *Latitude* of the Moon (that is, her Distance from the *Ecliptick*) is measured by the *Angle* in which the right Line connecting the *Center* of the Moon and Eye, is inclined to the Plane of the *Ecliptick*, agreeable to what was said concerning the *primary Planets*.

Besides, the Moon, like the other *primary Planets*, being an opaque, rough, *spherical Body*, reflecting back the Sun's Rays falling upon it, that Half of the Moon's Body, which is turned towards the Sun, is illuminated by him, whilst the other Half, which is opposite, is involved in Darkness; but the Face of the Moon, that can be seen by the *Inhabitants* of the Earth, is that which is turned toward the Earth, and therefore, according to the various Position of the Moon, in respect of the Sun and Earth, we do observe different Illuminations; one time a larger, at another time a lesser Portion of the illuminated Surface is to be seen; sometimes there is no Part of it visible,

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ble, and sometimes we see the Whole, and see the Moon with her full Face : For the better understanding of this Matter, we will explain it by Fig. 11. Plate 6. in which let S represent the Sun, T the Earth, R T I a Portion of the Earth's Orbit, which it describes in its *annual Course* round the Sun.

Let A B C D E F G H be the *Orbit* of the Moon, in which she turns round the Earth in the Space of a Month from the *West* towards the *East*.

When the Moon is in A, the Point of her *Orbit* opposite to the Sun, all the illuminated Face of the Moon will be turned towards the Earth, and be visible by its Inhabitants, and then the Moon is said to be full, and shines all Night long ; and in respect of the Sun, she is said to be in Opposition ; for the Sun and Moon are seen in opposite Parts of the Heavens, the one rising in the *East*, when the other sets in the *West*. When the Moon comes to B, the whole illuminated *Disk* M P N is not turned towards the Earth, there being a Part of it M P, not to be seen by us, and then the visible Illumination will be different from a *Circle*, and the Moon will appear *Gibbous*, such as is marked in B Fig. 12. Plate 6.

The Moon arriving at C, where the *Angle* C T S is nearly right ; there, only one Half of the illuminated Part is turned towards the Earth at T, and to be seen from thence, and then we observe a Half Moon as in C Fig. 12. and then she is said to be *Bisected* or *Dichotomised*, that is, cut in Halves. In this Position

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tion the Sun and Moon are removed one fourth Part of a *Circle* from each other, and the Moon is said to be in her *Quadrature*.

The Moon going forwards to D, the Face of the Moon turned towards the Earth, is for the most Part in Darknes, the Portion M P, of the illuminated Face M P N, being turned from the Earth, the *Circle* bounding Light and Darknes with the *Circle* of *Vision*, doth form two small *Angles*, and will look like what we call *Horns*, and the *Phases* seen from the Earth will appear as in D, Fig. 12. Plate 6.

When the Moon is come to the Point E, or in *Conjunction* with the Sun, all the inlightened Half will be turned from the Earth, and consequently the Moon will be entirely dark, and become a New Moon; soon after she will appear at F, and shew her *Horns*, which are always turned from the Sun. Afterwards being upon the Increase, she will appear a Half Moon at G, then *Gibbous* at H, and returns again to A, where she appears again to be full, to the Earth at T. See Fig. 11, and 12.

Tho' the Time of the Moon's Revolution about the Earth be but 27 Days $7\frac{3}{4}$ Hours, which is called a *Periodical Month*: Yet, by a Month, or entire *Lunation*, is commonly understood all that Space of Time that is spent from one New Moon to the next following, which is called a *Synodical Month*, and is greater than a *Periodical Month*, because during the whole *Periodick Month*, the Earth itself, together with the Moon its Attendant, is advanced

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advanced almost a whole *Sign* towards the *East*, so that the Point of the *Orbit*, which in the former Position was placed in a right Line joining the *Centers* of the *Earth* and *Sun*, is now more *Westerly*, and therefore when the *Moon* is again at that Point, it will not be seen in *Conjunction* with the *Sun*; for let A B (Fig. 13. Plate 6.) represent a Portion of the *Orbit* of the *Earth*, and when the *Earth* is at T, suppose the *Moon* is in L, and proceeds in describing her *Orbit* L A C D; the *Earth* in that Time is carried from T to t, 27 Degrees forward in its *Orbit*, and the *Orbit* of the *Moon* is in the Position l a c d, the Point of the *Orbit* L, will be now in the Line t l, parallel to the former T L.

Hence it is plain, that when the *Moon* is come to l, having describ'd its whole *Orbit*, that it is not arrived at a *Conjunction* with the *Sun*, but must still go further, and move through the *Arch* l M, before it can get between the *Earth* and the *Sun*, which is an *Angle* of 27 Degrees, and because the *Earth* is still going forward, therefore it's required that the *Moon* describe an *Arch* greater than l M, to be in *Conjunction* with the *Sun*; so that a *Synodical Month* consists of 29 Days $12\frac{3}{4}$ Hours, that is the Time the *Moon* takes to finish an intire *Lunation*, and all the various Changes of its Appearances.

Observations have discovered to us, that the *Moon* is constantly changing her Distance from the *Earth*, which ariseth from the *Elliprick Orbit*,

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Orbit, which she describes about the *Earth*, as (A B C D, Fig. 14. Plate 6.) having the *Earth* in one of its *Focus*'s at T, it is plain, that when the *Moon* is in C, she is nearest the *Earth*, and is then said to be in *Perigee*; and in *Apogee* when in A, that is, when farthest removed from the *Earth*.

The same Face of the *Moon* is always turned towards us, which ariseth from her Motion wherewith she turns round her *Axis*, in the same Time that she moves round the *Earth* in her *Orbit*.

When there are no Clouds in our Air, the *Moon* constantly appears with the same *Lustre*; from which it is apparent, that there are no Clouds nor Vapours in the *Moon*, from whence Rain may be generated, for such would sometimes cover some of its *Regions* from our Sight, which we never observe them to do.

It is also probable, that the *Moon* has no *Atmosphere* to surround her; for the *Planets* and *Stars*, which are sometimes seen very near her Limb, have not their Light *refracted*, as it is when it passes through our *Atmosphere*.

If the Surface of the Moon were smooth and polish'd like Looking-Glass, it would not then reflect Light upon all Sides, and every Way; but it would shew us only, in some Positions, the Image of the *Sun* no bigger than a Point, but with an immense Lustre. But as in all our *Earthly* Bodies, so in the Moon, her Surface is very rough and uneven, upon which account it diffuses the Light by reflecting

see Buff book 64.

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reflecting it to all Sides, without producing any Image of the *Sun*, as polished Glasses do.

But the Surface of the *Moon* is not only rough and uneven, but there are upon it prodigious high Mountains, and deep Vallies, which cover the whole Face of the *Moon*: This we thus prove; If there were no Parts in the Moon higher than the rest, no Prominent Points, then a right Line in the *Dichotomy* or Quadrature, and an Elliptick Line in all the *Phases* would terminate the light and dark Parts of the Disk; but when the *Moon* is viewed with a Telescope, we find that there is no regular Line that separates Light and Darknes in the *Moon's* Surface, but the Confines of these Parts appear as it were tooth'd, and cut with innumerable Notches and Breaks; and even in the dark Part, near the Borders of the lucid Surface, there are some small Places inlighten'd by the *Sun's* Beams, and upon the fourth Day after the *New Moon*, there may be perceiv'd some shining Points, like Necks or small Islands within the dark Body of the *Moon*; but not far from the Confines of Light and Darknes, there are observed other little Spots which join to the inlightened Surface, but run out into the dark Side, which by Degrees change their Figure, till at last they come wholly into the illustrated Face, and have no dark Parts round them. Afterwards we observe many more shining Spaces to arise by Degrees, and to appear within the dark Side of the *Moon*, which before they drew
near

Fig. 12.

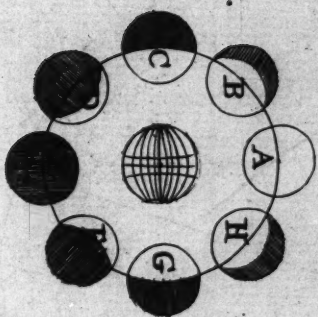


Fig. 11.

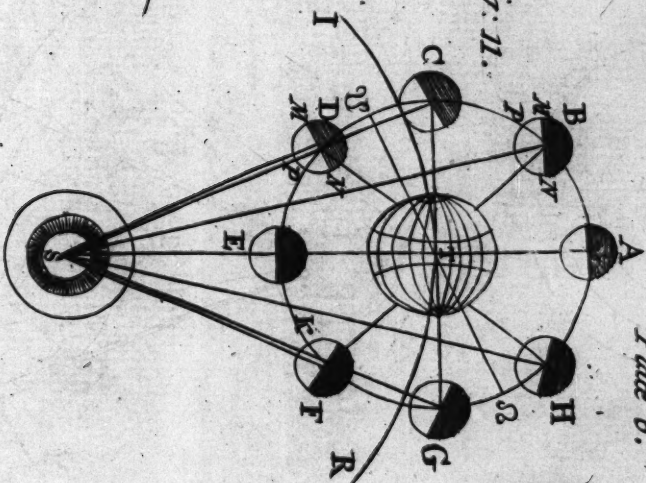
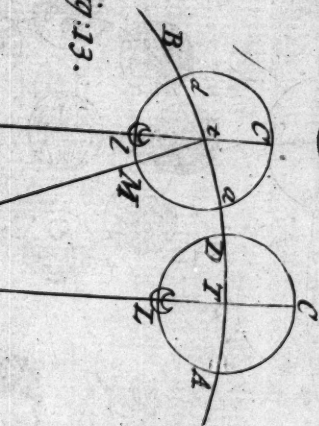


Fig. 13.



near to the Confines of Light and Darkneſs were inviſible, being without any Light, but wholly immerſed in the Shadow; the contrary is obſerved in the decreaſing *Phaſes*, where the *lucid Spaces*, which joined the illuminated Surface, by Degrees recede from it, and after they are ſeparated quite from the Confines of Light and Darkneſs, remain for ſome Time viſible, till at laſt they diſappear; now it is impoſſible that this ſhould be, unleſs theſe ſhining Parts were higher than the reſt of the Surface, ſo that the Light of the *Sun* might reach them.

Theſe ſhining Points ſituated in the *Moon's* Surface, without the Confines of the illuminated Surface, are the Tops of very high Mountains, which riſing far above the other Parts of the Surface, are ſooner reached by the *Sun's* Beams, and remain longer in the Light than the reſt of the Parts do which are lower. Beſides theſe we likewiſe obſerve, even in the illuminated Face of the *Moon*, many dark and obſcure Spots, which ſeem to be only Caverns or large Cavities, on which the *Sun* ſhining obliquely, and touching only their upper Edge with his Light, the deeper Places remain without the Light; but as the *Sun* riſeth higher upon them, they receive more Light, and the Shadow, or dark Parts, grows ſmaller and ſhorter, till the *Sun* comes at laſt to ſhine directly upon them, and then the whole Cavity will be illuſtrated, and the Parts, which were obſcure before, will then look as
bright

bright as the Tops of the Mountains. From these constant Observations it is plain to a Demonstration, that the *Moon's* Face is cover'd with Mountains in some Places, and that in others it is cut with deep Pits and Caverns.

The *Lunar* Mountains are much higher in proportion to the Body of the *Moon* than any Mountains upon our Globe, for a *Geometrian* can take the Height of them as easily as he can find the Measure of a Mountain upon our *Earth*: The Way of finding the Height of a *Lunar* Mountain is this; Let E G D, Plate 12. be the Hemisphere of the *Moon* illuminated by the *Sun*, and E C D the Diameter of the Circle bounding Light and Shadow, A the Top of a Hill: Within the dark Part, when it first begins to be illuminated, observe with a Telescope the Proportion of the right Line A E, or the Distance of the Point A, from the lucid Surface to the Diameter of the *Moon* E D, and because in this Case the Ray of Light E S touches the Globe of the Moon, A E C will be a Right Angle, by the Sixteenth Proposition, Book III. of *Euclid*, and therefore having, in the Triangle A E C, the two Sides A E and E C, we can find out the third Side A C, from which subducting B C or E C, there will remain A B the Height of the Mountain. *Ricciolus* affirms, That upon the Fourth Day after the *New Moon*, he has observed the Top of a Hill called St. *Katherine* to be illuminated, and that it was distant from the Confines of the lucid Surface about a Sixteenth Part of the Moon's

Moon's Diameter, or an Eighth Part of her Semi-diameter, and therefore if CE be 8, AE will be 1, and the Square of AC will be equal to the Squares of CE and AE , by Prop. 47. *Euclid I.* Now the Square of CE being 64, and the Square of AE being 1, the Square of AC will be 65, whose Square Root is 8.062, which expresseth the Length of AC , from whence deducting $BC = 8$, there will remain $AB = 0.062$, so that CB or CE is therefore to AB , as 8 is to 0.062, that is as 800 is to 6.2, and therefore since the Semidiameter of the *Moon* is 1182 Miles, if we make the Proportion as 800 to 6.2, so 1182 is to 9; we shall have 9 Miles for the Height of the Mountain, which is therefore three times higher than the highest Hill upon the Earth.

The other *Secondary Planets* (*viz.* *Saturn's* five *Satellites*, and *Jupiter's* four) like our *Moon*, do always accompany their *Primary Planets* in their Circuits round the *Sun*, and in the mean Time they perform their proper Revolutions about their *primary Planets*, and therefore they will have the same *Phases* and *Figures* when viewed from *Saturn* and *Jupiter*, that our *Moon* shews us. When they are in Opposition to the *Sun*, they appear to *Saturn* and *Jupiter* bright and full; when they come to a *Quadrantal Distance*, they look like *Half Moons*; before the *Conjunction*, they shew themselves in *horn'd Figures*, and when they

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come to be join'd in the same Line with the *Sun*, they totally disappear.

To explain the *Phænomena* of the *Satellites*, let A B T (Fig. 15. Plate 6.) represent the Orbit of the *Earth*, S the *Sun*, and let x y be a Portion of *Jupiter's* Orbit, in which, let *Jupiter* be in ν , the Center of his four Attendants; these *Satellites* or *Moons*, when they describe the superior Parts of their Orbits G H R, they are twice hid from us, viz. once by the Interposition of *Jupiter's* Body betwixt them and us; that is, when they happen to be in the right Line, which joins the Centers of the *Earth* and *Jupiter*: And again, they vanish and become invisible when they fall into the Shadow of *Jupiter*, which is, when they are in a right Line that joins the Centers of the *Sun* and *Jupiter*, and then they suffer *Eclipses*, which is always when they are at their Full, as seen from *Jupiter*. These *Eclipses* happen after the same manner as that of our *Moon*, by the Interposition of the *Earth* between the *Sun* and her.

When *Jupiter* is to the East of the *Sun*, and is seen in the Evening after *Sun*-setting, they are hid behind *Jupiter*, because of their visible Conjunction with him before they fall into his Shadow; and their second disappearing is in the *Eclipse* upon their entering the Shadow.

And when *Jupiter* is more *Westerly* than the *Sun*, and is only seen in the Morning, then they fall into *Jupiter's* Shadow at H, and are
eclipsed

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eclipsed before they are hid behind his Body at P. But when these *Moons* have a *retrograde Motion*; that is, when they are seen to go *Westward*, and describe the inferior Parts of their *Orbits*, then they only disappear at I, when they can't be distinguished from the Body of *Jupiter*.

When the *Satellites* seen from the *Sun*, are in their *inferior Conjunction* with *Jupiter*, or as seen from *Jupiter*, in *Conjunction* with the *Sun*, their *Shadows* will fall upon *Jupiter*, and some Part of *Jupiter's Disk* will suffer an *Eclipse*, and a *Spectator* within the *Shadow* would observe a *total Eclipse* of the *Sun*.

All the *Planets*, *Secondary* as well as *Primary*, observe a wonderful *Harmony* and *Proportion* to one another in the *Times* they take to finish their *Revolutions*; for the nearer any *Planet* is to the *Sun*, (or to the *Center* of his *Motion*) the sooner does he finish his *Circulation*, and his *Motion* is the quicker; and in this there is a constant and *immutable Law*, which all the *Bodies* of the *Universe* inviolably observe in their *Revolutions*, viz.

That the *Squares* of their *Periodical Times* are as the *Cubes* of their *Distances* from the *Center* of their *Orbits*, about which they perform their *Motions* regularly.

Now their *Periods* and *Mean Distances* from the *Sun*, are as in the following *Table*.

Statute Miles, each 5280 *English Feet*, and 4943 *French Feet*.

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The Periods.					Mean Distances.
	Days.	Ho.			
☿	10759	6	36	26	777000000
♃	4332	12	20	35	424000000
♄	686	23	27	30	123000000
☽	365	5	49	20	81000000
♀	224	16	49	24	59000000
♂	87	23	15	53	32000000
☾	27	12	35	16	
And is distant from the					600000
Earth					

The Time of the Diurnal Revolutions of such of the Heavenly Bodies as are already known to turn about their own Axis, is as follows,

	Days	Ho.	M.
The Sun,	} Revolves about its own Axis in the Space of	25	12 00
The Earth,		00	23 56
Mars,		01	00 40
Jupiter,		00	9 56
The Moon,		27	7 43

The Diameters of the Sun and Planets, are as follow,

	Miles.
The Sun's - - - -	763460
Saturn's - - - -	67876
Jupiter's - - - -	81155
Mars's - - - -	4444
The Earth's - - - -	7940
The Moon's - - - -	2175
Venus's - - - -	7906
Mercury's - - - -	4240

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By making Trial it will appear, that the Square of *Saturn's Periodical Time*, is to the Square of *Jupiter's*, as the Cube of *Saturn's Distance from the Sun*, is to the Cube of *Jupiter's Distance*; and as the *Periodical Motions* of the *Planets* are regulated by one general Law, so they are likewise retained in their own *Orbits*, after an uniform Manner by one sort of Force, which makes them tend to the *Center* of their *Orbits*, and is thence called the *Centripetal Force*, or in a Word, *Gravity*; for which we are indebted to the incomparable Sir *Isaac Newton*, he having demonstrated, that any Body when put in Motion, will move uniformly in a strait Line, if not hindered, by which it appears, that any *Planet* would fly out of its *Orbit* in a right Line (which is a *Tangent* to its *Orbit*) was it not acted upon, or pull'd back and retained in its *Orbit*, by *Gravity*, in which appears the Excellency of the *Copernican System* above any other; forasmuch as this *System* may be preserved by *Gravity* alone, uniformly propagated through the *Universe*, whereas all the other *Systems* require some (one or more) other Forces, besides that of *Gravity*.

And seeing all Bodies act upon one another according to the Quantity of Matter they contain, it will appear from the following Table, that the Sun, which is 116 times bigger than all the *Planets* put together, must be the Body to which the other *Planets* gravitate, or the Center about which they perform their

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Motions, and by whom they are retained in their *Orbits*.

The *Diameter* of the *Sun* is to the *Planets Diameters* nearly in the Proportion represented in the following Table.

The Diameter of the Sun is to the Diameter of	Saturn,	as 1000 is to	137
	Jupiter,		181
	Mars,		6
	The Earth,		12
	Venus,		12
	Mercury,		4

The Quantity of Matter in the primary Planets is in the following Proportion.

The Sun's	-	-	-	-	229600
Jupiter's	-	-	-	-	208.72
Saturn's	-	-	-	-	97.328
The Earth's	-	-	-	-	1
The Moon's	-	-	-	-	0.7

The Weight of Bodies, on the Sun's and following Planets Surfaces, is as follows.

The Sun	-	-	-	-	24
The Earth	-	-	-	-	1
Jupiter	-	-	-	-	1.99
The Moon	-	-	-	-	0.515
Saturn	-	-	-	-	1.7

The

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The Densities of the same are as the following Numbers.

The <i>Moon's</i>	-	-	-	-	700
The <i>Earth's</i>	-	-	-	-	387
The <i>Sun's</i>	-	-	-	-	100
<i>Jupiter's</i>	-	-	-	-	07.6
<i>Saturn's</i>	-	-	-	-	0.6

And because Spheres are to one another as the Cubes of their Diameters,

The Sun will be to	{	<i>Saturn,</i>	as 1000000000 is to	{	2571353
		<i>Jupiter,</i>			5929741
		<i>Mars,</i>			216
		<i>The Earth,</i>			1728
		<i>Venus,</i>			1728
		<i>Mercury.</i>			64

The Quantity of Matter in *Saturn* is 2400 times less than the Matter of the *Sun*; *Jupiter*, the biggest of all the *Planets*, the Matter that composes his Body is 1033 times less than the Matter of the *Sun*: But our *Earth*, if compar'd with the *Sun*, is but of a very small Magnitude, and not bigger than a Physical Point, for it is 500000 times less than the *Sun*; *Jupiter* is about 2000 times bigger than our *Earth*; *Venus* is of the same Magnitude with our *Earth*; but *Mars* and *Mercury* are less than our *Earth*.



S E C T. XII.

*Of the Parallaxes of the PLANETS
and STARS.*

SINCE all the apparent Diurnal Motions are perform'd uniformly round the Axis of the Earth, and not round the Place of the Spectator, who lives upon the Earth's Surface; he who observes the Motion of the Stars from this Surface, must find that they appear to move with a Motion that is not equal: For if a Body, by its Motion, describes equally the Periphery of a Circle, the Equality of Motion can be seen from no other Points than those in the Axis of this Circle. And therefore any Star or Phænomenon, seen from the Center of the Earth, will appear in a different Place from what it does when observ'd from the Surface; and this Difference of Place of the same Star, seen from the Earth's Center, and view'd from its Surface, is called the Parallax of that Star. Let A B, Pl. 12. be a Quadrant of a great Circle on the Earth's Surface, where A is the Place of the Spectator, and the Point V in the Heavens his Vertex or Zenith. Let V N H represent the starry Firmament, the Line A D the sensible

visible Horizon, in which suppose the Star C to be seen, whose Distance from the Center of the Earth is T C. If this Star were observ'd from the Center T, it would appear in the Firmament in E, and elevated above the Horizon by the Arch D E. This Point E is called the true Place of the Phænomenon or Star: But an Observer viewing it from the Surface of the Earth at A, will observe its Place in the Horizon at D, which is call'd the visible or apparent Place of the Planet: And the Arch D E the Distance between the true and visible Place, is named the Parallax of the Planet or Star.

If the Planet rise higher above the Horizon to M, its true Place visible from the Center is P, but its visible Place from the Surface is N, and its Parallax is the Arch P N, which is less than the Arch D E, and therefore the Horizontal Parallax is greatest of all Parallaxes, and the higher the Star rises, the less is its Parallax; and if it should come to the Vertex it would have no Parallax at all: For when it is in Q it is seen both from T and A in the same Line T A V, and there is no Difference between its true and visible Place; the further a Star is distant from the Earth, so much the less is its Parallax; so the Parallax of the Star F is G D, which is less than the Parallax of the nearer Star C: Hence it is plain, that the Parallax is the Difference of the Distances of a Star from the Vertex, when seen from the Center, and from the Surface of the Earth:

For

For the true Distance of the Star M from the Vertex is the Arch V P, but when observed from A its visible Distance is V N.

These Distances are measured by the Angles V T M and V A M, contained between the Line V T drawn to the Vertex, and the right Lines T M and A M drawn from the Center, and the Surface of the Earth to the Star M: But the Difference of these two Angles is T M A, for the External Angle V A M is equal to the two inward and opposite Angles A T M and A M T, and therefore A T M is the Difference of the two Angles V A M and A T M or V T M. This Angle A M T does therefore measure the Parallax, and upon that Account it self is frequently called the Parallax: And this is always the Angle under which the Semidiameter of the Earth A T appears to an Eye placed in the Star; and therefore when the Semidiameter is seen directly, there the Parallax is greatest, that is in the Horizon: When the Star rises higher, the Parallax is diminished in the Proportion we shall shew in the following Theorem.

The Sine of the Parallax is to the Sine of the Stars Distance from the Vertex in a constant and given Proportion, which is as the Semidiameter of the Earth to the Distance of the Star from the Earth's Center.

For by a well known Theorem in Trigonometry, in the Triangle A T M, the Sine of the Angle A M T is to the Sine of Angle T A M or V A M, as A T is to T M,

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T M, that is, in the constant Proportion of the Semidiameter of the Earth to the Stars Distance; and therefore the Sine of the Parallax in C is to the Sine of the Parallax in M, as the Sine of the Angle V A C is to the Sine of the Angle V A M; and therefore if the Parallax of a Star be known, when it is at any one Distance from the Vertex, we can find its Parallax at any other Distance from the Vertex: If any Star or Phænomenon be farther distant from the Earth than 15000 Semidiameters of the Earth, its Parallax will be so small that it will be insensible, and cannot be observed; for since T F is to T A as 15000 to 1, and as T F is to T A, so is the Radius to the Sine of the Angle T F A: Hence we shall find the Angle T F A less than 14 Seconds, which Angle is so small that it cannot be observed by an Instrument.

If we have the Distance of a Star from the Earth, we can easily find its Parallax, for in the Triangle T A C rectangular at A, having T A the Semidiameter of the Earth, and T C the Distance of the Star, the Angle A C T, which is the Horizontal Parallax, is found by Trigonometry. And again; If we have this Parallax, we can find the Distance of the Star, for in the same Triangle having A T and the Angle A C T, we may find out the Distance T C.

If a Star has no proper Motion of its own, its true Distance from any fixed Star, measured by an Arch of a Circle, always remains unchangeably

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changeably the same; but if it have a sensible Parallax, its apparent Distance will be thereby changed; and if the fixed *Star* be in the same Vertical with the Phænomenon, but higher than it, the Distance will appear to grow less as it rises higher: If the *Stars* be lower, as they ascend, the Distance will encrease, yet, seen from the Center, they will appear constantly to keep the same Distance from each other; and therefore the visible Distances of a Phænomenon, from a fixed *Star* which is near it, are not the real but apparent ones.

Let there be a Phænomenon, or *Star* appearing in the Horizon in C, if it were observed from the Center, it would be seen in the Conjunction with the fixed *Star* E, but the Spectator in A will see it in the same Line with the *Star* D, and will be distant from the *Star* E by the Arch D E: But as it rises higher into M, it will still appear from the Center of the Earth in Conjunction with the same *Star* E, which then will appear in P; but from the Surface of the Earth in A it will appear in N, nearer to the *Star* E than it was when in the Horizon; and therefore will not appear in Conjunction with the same *Star* D, as it did before, but will be distant from it by the Arch N d, making the Arch P d equal to E D; hence it follows, that if any Phænomenon always keeps the same Position in respect of the fixed *Stars*, and changes not its arcual Distances from them, it has no sensible Parallax: But even likewise if its Distance from the *Stars* be

be changed, yet if that Change be only so much as arises from its proper Motion, in that Case likewise it will have no sensible Parallax: But if any Phænomenon departs further from a fixed *Star*, or comes nearer to it than what it would do by its proper Motion, this Difference of Access or Recess is the Effect of a Parallax.

The Parallax of a *Star* in a Vertical Circle changes its Place in regard to the other Circles of the Sphere, and makes its visible Longitude, Latitude, and right Ascension, to be different from the true ones, which are seen from the Center, and from hence arise four other kinds of Parallaxes.

Let HO, Pl. 12. Fig. 2. be the Horizon, whose Pole is V, and EQ the Ecliptick, and its Pole P, V A a Vertical Circle passing thro' the *Star*, whose true Place is C, but apparent Place D, in the same Vertical, but nearer to the Horizon; so that the Parallax of Altitude is DC. Thro' the Pole of the Ecliptick, and the *Star*, draw the Circle of Latitude PCG, and G will be the true Place of the *Star* reduced to the Ecliptick; but a Circle of Latitude thro' the apparent Place D, will meet with the Ecliptick in H, which will be the visible or apparent Place of the *Star* in the Ecliptick: The Arch of the Ecliptick GH, intercepted between the two Circles of Latitude passing thro' the true and apparent Place, is called the Parallax of Longitude, and CN the Parallax of Latitude.

If the *Star* be in the Vertical Circle, which cuts the Ecliptick in the 90th Degree from the
the

the Horizon, *i. e.* in that Vertical which cuts the Ecliptick at Right Angles; as for Example; In the Point *c* of the Circle *VE*, the Parallax of Longitude will be nothing; for because the Vertical Circle *VE* is in this Case perpendicular to the Ecliptick, it will pass thro' its Poles, and will be the same Circle of Latitude in which is the true and apparent Place of the *Star*; and both these Places reduced to the Ecliptick, will coincide in the same Point: And here the Parallax of Latitude will be the same with the Parallax of Altitude.

The Eastern Quadrant of the Ecliptick is that which lies between the 90th Degree and the Point of it that rises: The Western Quadrant, between the 90th Degree and the setting Point thereof. A *Star* that is in the Eastern Quadrant has its apparent Longitude greater than its true Longitude, for while the *Star* rises the Parallax depresses it towards the East: So in the Figure, the visible Place of the *Star* in the Ecliptick is the Point *H*, which is more Easterly than the true Place *G*; but if the *Star* be in the Western Quadrant, its visible Longitude is less than the true, because the Parallax thrusts it Westward.

Let the Circle *EQ*, which before represented the Ecliptick, be now in the Place of the Equator, and *P* its Pole, *PVH* the Meridian, *VCA* a Vertical Circle passing thro' the *Star*, in which let *C* be its true Place, and *D* its apparent; *PCG*, *PDH*, Secondaries of the

the Equator or Circle of Declination, passing thro' the true and apparent Places of the *Star*, meeting with the Equator in G and H. The Point G shews the true right Ascension of the *Star*, H its apparent, and the Distance G H is called the Parallax of right Ascension. The true Declination of the *Star* is G C, and its visible is H D, and their Difference N C is the Parallax of Declination. If a *Star* be to the East of the Meridian, the visible right Ascension is greater than the true; if to the West of it, it is less; and when the *Star* culminates, the Parallax of right Ascension is nothing, because the same Circle of Declination does there pass thro' both the apparent and true Place.

The Astronomers have invented several Methods for finding the Parallaxes of *Stars*, that from thence their Distances from the Earth may be known; for if we knew this, we could make some Estimate of the Largeness and Amplitude of the Universe. Let us now give some of the Methods which the Astronomers have contriv'd for searching out the Parallaxes.

First; Observe the Planet when it is in the same Vertical Circle with two other fixed *Stars*. Let V B, Fig. 3. be the Vertical Circle, in which are seen the fixed *Stars* C and D, and the Phænomenon or *Star* S, whose apparent Place will be likewise in the same Vertical, which suppose to be E; and if the *Star* have no proper Motion of its own, it will constantly be in the same Line with the two

Stars:

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Stars: After some Time, again observe the Position of the Phænomenon with the same *Stars*, when it is not in a Vertical Circle with them, but rather in a Circle parallel to the Horizon; *i. e.* Suppose the fixed *Star* in *c* and *d*, and let the visible Place of the *Star* be *e*; but its true Place is in the Line *c d*, which joins the two fixed *Stars*. It is also in the Vertical *V e*; and therefore it must be in the Point where these Lines cut one another, that is in *S*. Observe the Distances of the fixed *Stars* *d* and *c*, and of the *Star* *e* from the Vertex *V*: Measure likewise with an Instrument the Arches *d e*, *c e*, and *d c*, and because *e* is the apparent Place of the *Star*, and *S* its true Place, the Arch *e S* is its Parallax. In the Triangle *d V c* we have all the Sides, wherefore we can find the Angle *V d c* again in the Triangle *V d e*. We have all the Sides, therefore we can find the Angle *d V e*. Lastly, In the Triangle *d V S*, we have the Side *d V*, and the Angle *d V S* and *V d s*, which we found before, therefore we can find the Side *V S*, which being subtracted from *V e*, known by Observation, leaves *S e* for the Parallax, which was to be found out.

The Parallax of a *Star* may be likewise easily found this Way, Fig. 4. Observe when the Phænomenon is in any Vertical with a fixed *Star* which is near it, and then measure its apparent Distance from this *Star*: Then observe again, when the Phænomenon and fixed *Star* are in equal Altitudes from the Horizon;
and

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and then again, measure their Distance. The Difference of these Distances will be very near the Parallax of the Star: For let HO be the Horizon, V the Vertex, VE a Vertical Circle passing thro' the Star in E , and the fixed Star in D , let the true Plan of the Phænomenon be S , so that SE is the Parallax of Altitude, and the Difference of the Stars, and the Phænomenon's Height, is in this Case their visible Distance. Afterwards observe, when the Star and the Phænomenon come to be equally distant from the Horizon, and then measure their Distance by an Instrument: This visible Distance is nearly equal to their true Distance; for let the true Plan of the Phænomenon be S , the Parallax Se is very small in Comparison of the Arch Ve , and therefore Ds and De will be very near equal; for if the Parallax SE were a whole Degree, yet even then ds and de would not differ above one Minute, therefore the Distance De being measured, we shall have their true Distance ds or DS , which is greater than DE . And if from DS we subtract DE , known by the first Observation, there will remain SE the Parallax, which was to be found. The Parallax of a Phænomenon may likewise be obtained by an Observation of its Azimuth and Altitude, and by marking the Time between the Observation and its Arrival at the Meridian. Let $HVPO$ be the Meridian, V the Vertex, P the Pole, HO the Horizon, and VB a Vertical Circle, passing thro' the true and apparent Plan; thro' which

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draw

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draw also Circles of Declination P S C, P E. The Arch of the Horizon B O is the Azimuth of the Star, which must be observed, in the Manner which we shew'd before. Observe likewise the Arch V E, the Distance of the Phænomenon from the Vertex, and mark the Moment of Time when these Observations are made; then stay till the Phænomenon or Planet comes to the Meridian, and note the Moment of its Arrival there, which may either be done by a Pendulum-Clock, or by an Observation of a Planet: Let the Distance of Time between the first Observation, and the second of the Stars being in the Meridian, be converted into Degrees and Minutes of the Equator, and we shall have the Arch Æ C , which measures the Angle UPS: We have the Side V P, the Distance of the Vertex from the Pole, and the Angles P V S and V P S, whereby we can find the Arch V S the true Distance of the Phænomenon from the Vertex. This being subtracted from the observed Distance V E, there will remain the Parallax SE, which was to be found. It is here to be noted, that for to reduce the Time into Degrees and Minutes of the Equator, that the Time must be first reduced into Hours and Minutes of the *Primum Mobile*, or to the Time of the Revolution of the Heavens, which Hours are somewhat shorter than the Solar Hours, or if you keep the Solar Hours, you must reckon for each of them 15 Degrees, 2 Minutes, 27 Seconds,

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conds, and 51 Thirds; and so proportionably for the rest of the Particles of Time.

Suppose HO an Arch of the Horizon, AM the Meridian, in which P is the Pole, and V the Vertex of the Plan. Suppose E the apparent Plan of the Star, before the Arch comes to the Meridian, observe the Arch VE its Distance from the Vertex, and its Azimuth $EV M$: Let the true Plan of the Star be S , its Parallax is SE , mark the Time of the Observation. Again, After the Star has passed the Meridian, observe when it is exactly at the same Distances from the Vertex, so that V may be equal to VE : And here since the visible Distances of the Star from the Vertex are equal, the real Distances will be likewise equal; *i. e.* $VS = V s$. Take the Time between the first and second Observation, and turn it into Degrees and Minutes of the Equator, and we shall have the Angle SPS , the Half of which is the Angle SPV ; therefore in the Triangle SVP we have the Angle SPV , and the Angle $SV P$, which is the Complement of the Azimuth to two Right Angles: Also the Side VP the Distance of the Pole and Vertex; from them we shall find VS the true Distance of the Star from the Vertex, which being subtracted from VE , leaves SE for the Parallax.

These Practices depend upon Observations of the Azimuths, but without observing them, the Parallax may be known by finding out the apparent and true right Ascensions, and from them, by Calculation, finding the Azimuth:

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For by observing the Distance of a Phænomenon from two known fixed Stars, we can compute its apparent right Ascension, according to the Method explain'd in Lecture. Then again, when the Star comes to the Meridian, by the same Method find its right Ascension, which is the true right Ascension, or the Point where the Circle of Declination passing thro' the true Place of the Star cuts the Equator. Knowing then the apparent right Ascension of the Star in the Vertical VB , and the Point of the Equator, which at the same Time culminates, we shall likewise know the Angle VPE ; therefore in the Triangle VPE , having the Sides VP , VE , and the Angle VPE , we can find the Angle PVE , which determines the Azimuth. But having the true right Ascension of the Star, as was observed in the Meridian, and the Point of the Equator culminating at the first Observation, the Distance between them will give us the Angle VPS : Therefore in the Triangle VPS , having the two Angles VPS and SPV , as also the Side VP , we can find the Side VS , the real Distance of the Star from the Vertex, which subtracted from VE , leaves SE the Parallax, which was to be found.

After the same Manner, by the apparent and real Longitude of a Phænomenon, the Parallaxes may be investigated. The apparent Longitude is found by observing the Distance of a Phænomenon from two fixed Stars, whose Longitude and Latitude are known; and the true

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true Longitude is had, by making the same Observations, when the Star is in the 90th Degree of the Ecliptick, where the apparent and true Longitude coincide.

By these, and the like Methods, if any Phænomenon has a Parallax not less than one Minute, it may be found out in the Moon as we find the Parallax very considerable, which, in the Horizon, amounts to about a Degree and more: But there are some particular Methods only applicable to the Moon, by which its Parallax is known. In an Eclipse of the Moon observe when both its Horns are in the same Vertical Circle, and then, in that Moment, take the Altitudes of both Horns: The Difference of these two Altitudes being halved, and added to the least, or subtracted from the greatest, does give near the visible Altitude of the Moon's Center: But the true Altitude is nearly equal to the Altitude of the Center of the Shadow at that Time; nor need we know the Altitude of the Center of the Shadow, because we know the Plan of the Sun in the Ecliptick, and its Depression under the Horizon, which is equal to the Altitude of the opposite Point of the Ecliptick, in which is the Center of the Shadow, and therefore we have the true Altitude of the Moon, and the apparent Altitude, whose Difference is the Parallax.

As the Distance of the Moon grows less, according as it recedes from its Apogæum, her Parallax must in the same Proportion be in-

creased, constantly the nearer she comes to us: Therefore the Artists make Tables which shew the Horizontal Parallax for every Degree of its Anomaly.

The Methods we have given for finding the Parallax shew the Moon has a great Parallax, and is very near us, but none of them is sufficient for finding out the Parallax of the Sun; for that is so small, that the Observations requisite cannot be made accurately enough to determine it, for an Error in observing can scarcely be avoided, which is not equal or greater than the Sun's Parallax. This Defect of Observation put the ancient Astronomers on the Search of other Methods peculiar to the Sun, for finding out his Parallax; but even those Methods, though they make manifest the Acuteness and Sagacity of the Ancients, yet are not sufficient in so nice and subtle a Disquisition: However, they are useful to shew that the Distance of the Sun from the Earth is very great in Comparison of the Moon's Distance from the same. For finding the Parallax of the Sun, the Astronomers are forced to have recourse to the Parallaxes of the Planets that are next to us, as *Mars* and *Venus*, that are sometimes much nearer to us than the Sun is: Their Parallaxes they endeavour to find by some of the Methods above explained; and if these Parallaxes were known, then the Parallax and Distance of the Sun, which cannot directly by any Observations be attained, could easily be deduced from them: For from the
Theory

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Theory of the Motions of Earth and Planets, we know at any Time the Proportion of the Distances of the Sun and Planets from us; and the Horizontal Parallaxes are in reciprocal Proportion to these Distances; wherefore knowing the Parallax of a Planet, we may from thence find the Parallax of the Sun.

Mars, when he is in an Acronical Position, that is, opposite to the Sun, is twice as near to us as the Sun is, and therefore his Parallax will be twice as great: But *Venus*, when she is in her inferior Conjunction with the Sun, is four times nearer to us than he is, and her Parallax is greater in the same Proportion; therefore tho' the extream Smallness of the Sun's Parallax renders it unobservable by our Senses, yet the Parallax of *Mars* or *Venus*, which are twice or four times greater, may become sensible. The Astronomers have bestowed much Pains in finding out the Parallax of *Mars*; but of late *Mars* was in his Opposition to the Sun, and also in his Perihelion, and consequently in his nearest Approach to the Earth, and then he was most accurately observed, by two of the most eminent Astronomers of our Age, who determined his Parallax to have been scarce 30 Seconds; from whence we can easily collect, that the Parallax of the Sun is scarce 11 Seconds, and his Distance about 19000 Semidiameters of the Earth.

By an Observation of the Body of *Venus*, seen passing by the Body of the Sun, which

will happen in *May* 1761, Dr. *Halley* has shewn a Method of finding the Parallax and Distance of the Sun to a great Nicety, viz. within a 500th Part of the Whole; and we must wait till then before it can be determined to so great an Exactness.



S E C T. XIII.

Of the Annual Motion of the EARTH.

TH E *Earth* which we inhabit, is one of those *Planets* which moves round the *Sun*, performing its *Revolution* in the Space of a Year, or 365 Days, 5 Hours, and 49 Minutes, and at the same time turns round its own *Axis* every 24 Hours.

To explain the *Annual Motion* of the *Earth*, Let A B C D, &c. Fig. 16. Plate 7. represent the *Orbit* of the *Earth*, in which it is carried from *West* to *East* in the Compass of a Year; and γ , δ , II, &c. the apparent *Annual Path* of the *Sun* among the fixed Stars; which let be divided into 12 equal Parts, and the several Lines S A, S B, S C, &c. being drawn, will divide the *Orbit* of the *Earth* into 12 unequal Parts.

A Spectator

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A *Spectator* in S (the Sun) observing the *Earth* in A, it will appear to him among the fixed Stars, viz. γ , and in its Mean Distance from the *Sun*, the *Earth* moving forward in its *Annual Motion* from A to B, and from B to C and D, the *Spectator* in S, will see the *Earth* move forward among the fixed Stars from γ to δ , from δ to π and ς , in which Point it will appear in its *Perihelion*, or nearest Distance from the Sun; and the *Earth* continuing to move forward in its *Orbit* from D, through D E F, the Observer in S, will see it describe in that Time the *succeeding Quadrant* of the *Ecliptick*; that is ς , α , ϖ , and in ω will observe the *Earth* again in its Mean Distance from the Sun. Also while the *Earth* passes through G H I, the Observer will see it among the Stars ω , η , ζ , and at K the *Earth* appears then in its *Aphelion*, or in its *greatest* Distance from the *Sun*, and so continues to move through K L M, which makes it appear from S, to be with the Stars φ , χ , ψ , which brings it to γ again, being one intire *Revolution* round the *Sun*.

The *Spectator* having viewed the *Annual Motion* of the *Earth* from the *Sun*, the Center of that *Motion*; let us now bring him from thence to our *Earth*, and let him be carried by it round the Sun, and let us *imagine* the *Earth* in G, the *Spectator* sees the same Face of the *Heavens*, and the very same *Constellations*, as we have said before he did while he was in the *Sun*; the only Difference will be, that as before

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before he *imagined* the *Sun* in the *Center*, and the *Earth* in the *Heavens*, he will now suppose the *Sun* in the *Heavens*, and himself with the *Earth* at Rest in the *Center*; and the *Observer* being carried along with the *Earth*, and partaking of the *Annual Motion* common to them both, he will observe all the Parts of the *Earth* and all the *Bodies* fixed on its *Surface*, to keep the same Distance with respect to one another, and to his own *Eye*, and therefore he cannot by his own *Eye*, perceive either his own *Motion*, or that of the *Earth*. But observing the *Sun*, when the *Earth* comes to K, he will see the *Sun* with the *Stars* $\S$, and will perceive that he has chang'd his Place among the *Stars*, and that he has moved from γ to δ and Π to $\S$, and while the *Earth* goes on in its *Progress* to M, the *Sun* will be seen from thence to have moved thro' the Signs $\S$, α , ϖ ; and again, while the *Earth* describes the *Semicircle* A B C D E F, the *Sun* will appear to have moved in the *concave Surface* of the *Heavens* through the six Signs $\equiv$, m , $\ddagger$, v , $\equiv$, and $\times$, and therefore an *Inhabitant* of the *Earth* observes the *Sun*, which is really *immoveable*, to go through the same *Circle* in the *Heavens*, and in the same Space of Time that a *Spectator* in the *Sun* would see the *Earth* describe that *Circle*. Hence arises that *apparent annual Motion* of the *Sun*, by which it is observed to go forward every Day by little and little towards the *Eastern Stars*: So that any Star near the *Ecliptick* that rises

rises when the Sun rises, after some Days the Star will rise before the Sun, the Sun having got to the Eastward of it: So likewise a Star that is seen after the Sun sets at a considerable *Distance* from him, in the Space of some few Days, will set with the Sun; and after that, will rise before him in the *Morning*, and set before him at *Night*.

The *Revolution* of the Earth about the Sun is not *Circular*, for the great *Kepler*, by a most certain and infallible Method of *Reasoning*, has shewn, that the Motion of the Earth (as of all the other *Planets*) is perform'd in an *Ellipse*, having the Sun in one of the *Focus's*, and that its Motion in this *Ellipse* is really unequal, sometimes *quicker*, and sometimes *slower*, and that according to its Distance from the Sun.

The *Axis* of the *Ellipses* A P (Fig. 17. Plate 7.) is called the Line of the *Apsides*; the Point A, is termed the *Aphelion*, and P, the *Perihelion*; and S C, the Distance between the Sun in the *Focus* and the *Center*, is called the *Excentricity*. If from the *Center* C, there be erected upon the *Axis* the Perpendicular C E, meeting with the Orbit in E, and there be drawn from the *Focus* the Line S E, this Line is call'd the Mean Distance of the Planet from the Sun, which is equal to half the *Axis*, it exceeding the shortest Distance S P, as much as the longest Distance S A exceeds it,

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In the *Orbit* of the Earth, the *Excentricity* $S C$ is only 17 of such Parts as $S E$, the Mean Distance consists of 1000.

The Motion of the Earth is not at all equal, yet it is *regulated* by a certain immutable Law, from which it never deviates; which is, that a Line or Ray drawn from the Center of the Sun to the Center of the Earth, does so move, that it describes an *Elliptick Area* about the Sun, always proportional to the Time: And this Law holds in all the *primary Planets*: Thus, let the Planet be in A , from whence, in a certain Time, let it go to B , the Space or *Area* which the Ray $S A$ describes, is the Figure $A S B$; again, when the Planet comes to P , from which Point, suppose it to move through the *Arch* $P D$ in the same Space of Time that it did through the *Arch* $A B$, which *Arches* must be unequal, and nearly in a *reciprocal Proportion* to their Distance from the Sun; the *Area* $S P D$, described by the *Radius* $S P$, will be equal to the *Area* $P B A$; the *Arch* $P D$ must be so much in Proportion greater than the *Arch* $A B$, as $S A$ is greater than $S P$, otherwise the *Areas* described in the same Time would not be equal. This *Law* is sufficiently *demonstrated* by the most learned *Kepler*, and unto this his *Invention* all the *Astronomers* do now give their *Assent*; for there is no other *Rule*, which so well satisfies for all the *Appearances* of the *Planets Motions*.

The Earth being farthest from the Sun in our Summer, (as appears by Fig. 16. Plate 7.) so that when the Sun appears in *Cancer*, the Earth is in K, its greatest Distance from the Sun, it may be asked, Why the Earth grows warmer while it is still removing farther from the Sun? And again, in the Winter, Why it should be cold, notwithstanding its nearer Access to him? To answer which, it is to be observed, that the Sun being low in our *Horizon* all the Winter, the Beams pass through a much greater *Quantity* of *Air*, or it is deeper *immersed* in our *Atmosphere* in Winter than in Summer, when the Sun approaches nearer to our *Vertex*; and the Difference is so very great, that when the Sun is near the *Horizon*, we can look upon him without hurting our Eyes, the Force of the Rays being broke by the Reflection on, and Refraction by so many Particles of the denser *Air*.

Another Cause which produces the Variety of *Seasons* is, that in Summer the Day being longer than the Night, we receive a greater Quantity of Heat from the Sun, than can be removed in the short Night, and this Heat encreaseth with the Length of the Day, and continues so to do after the longest Day, till the Sun return almost to the *Equator*.

The Inhabitants of the other *Planets*, will observe such Motions in the Sun, as we do from our Earth, *viz.*

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An Inhabitant of *Jupiter* will think that the Sun turns round their Earth in 12 of our Years; that *Circle*, which the Sun, by his *Annual Motion* appears to them to describe, is not the same with our *Ecliptick*, by reason of the *Latitude* of *Jupiter*. And for the same Reason, the Sun seen from *Saturn* will appear to move in another Circle distinct from either of the former, finishing his *Revolution* in about 30 of our Years.

Also, from *Mars*, he will appear to describe a *Circle*, different from either of the former, in two of our Years; since it is impossible that the Sun can have all these Motions really in it self, and there can be no Reason given why any of them should belong really to the Sun more than the rest; we may therefore *reasonably* affirm, that there are none of them real, but that they are all apparent, and arise from the Motions of the respective *Planets*.



Fig. 16.

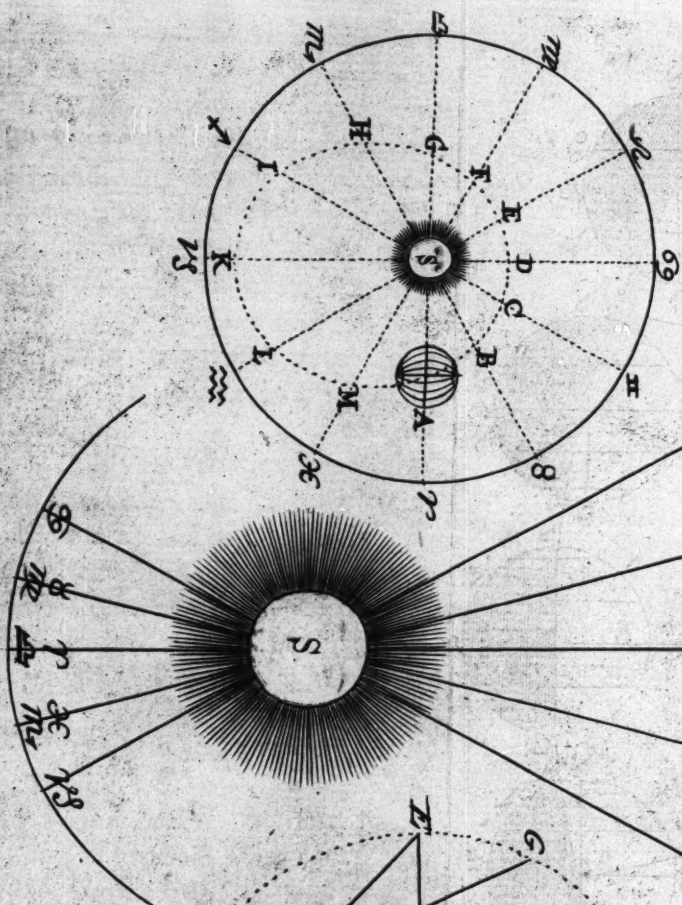
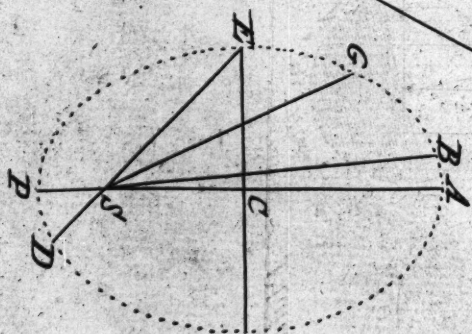


Fig. 17.



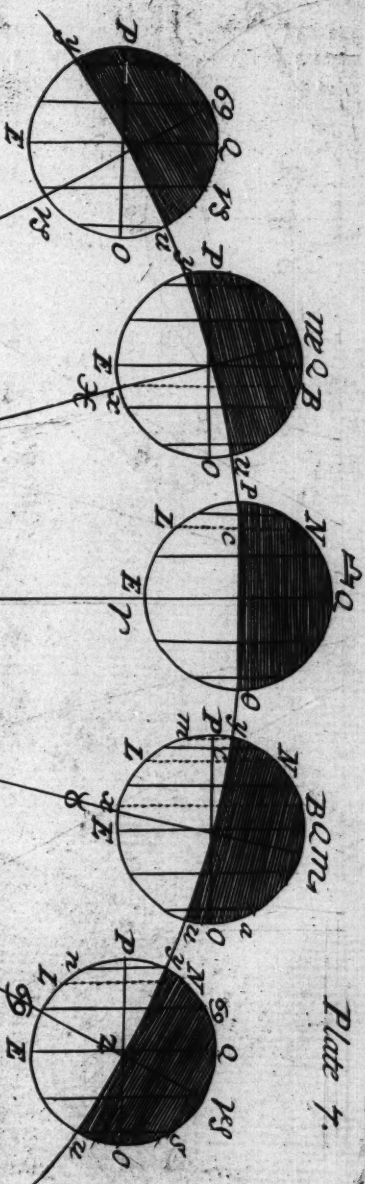


Fig. 18.

Fig. 16.

Fig. 17.

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S E C T. XIV.

Of the Inequality of Days and Nights.

TO explain the Variety of the Days and Nights, and the Seasons of the Year; suppose the Earth in $\sphericalangle$ (Fig. 18. Plate 7.) in its *Orbit*, carried from *West* to *East*, revolving at the same Time about its own *Axis* in twenty four Hours from *West* to *East*, P will represent the *North Pole*, and O the *South*, E Q the *Equator*, whose *Plane* is inclined to the *Plane* of the *Ecliptick* by an *Angle* of $23\frac{1}{2}$ Degrees. It is plain, if the Earth be in *Aries* or *Libra*, where the Rays joining the Sun and Earth's Centers, cut perpendicular its *Axis* P O, the Sun will appear in the *Equinoctial Circle*, and consequently declines neither to the *North* or *South Pole*, but seems to describe, in its diurnal Motion, the *Equator* it-self: In which Situation the *Illumination* of the Earth made by the Sun, extends it-self to both *Poles* P and O.

The *Axis* P O, which in this Case represents the *Horizon*, or that Circle which separates the *illuminated* from the *darkened Hemisphere*,

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misphere, divides the *Equator* and all its *Parallels* equally : And therefore any *Parallel* of the *Equator* being carried round by the equal *Diurnal Motion*, is as long in the *Darkness* as in the *Light* ; that is, the Day and Night will then be equal all over the Earth ; for Example, Let *L N* represent the *Parallel* of *Latitude* for *London*, it is plain, that the said *Parallel* is equally divided by the *Circle*, separating the *enlightened* from the *darkened Hemisphere*, consequently the *Diurnal Arch* is equal to the *Nocturnal*.

Supposing now the Earth at *m*, the Rays of the Sun *S m* will not be perpendicular to the *Axis* of the Earth *P O*, but will meet with the same in some other *Parallel*, which will be between the *Equator* and the *Tropick* of *Cancer* ; for the Earth in its *Annual Motion* being removed from the *Equator* about 10 Degrees, the Sun will then appear to have 10 Degrees of the *Northern Declination* equal to the Arch of the *Meridian* *E x*, therefore the perpendicular Ray of the Sun will not meet with the Earth at *E* the *Equator*, but in *x*, from which Point draw *x B* parallel to the *Equator*, it will represent the *Parallel*, which the Sun appears to describe for that *Day*, by the *Diurnal Motion* of the Earth.

The enlightened *Hemisphere* being always 90 Degrees on each Side of the Circle the Sun appears to describe, he shall then shine to *y*, 10 Degrees on the other Side *P* the *North Pole*, and to *u*, 10 Degrees short of *O* the
South

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South Pole, and describing a Circle *parallel* to the *Equator* at the Distance Qy , the whole Tract betwixt that *Circle* and the *North Pole* P , shall have the Sun still in *View*, and consequently continual Day; it's plain that the like Space lying betwixt the *Circle* Ua and the *South Pole* O , shall have continued *Darkness*; the *Circle* yu will represent the *Horizon*, being perpendicular to the *Ray* of the Sun Sx : But in this *Position*, all the *Parallels* betwixt the *Equator* and the *Circle* ym towards the *North Pole*, are cut by the *Circle* yu bounding Light and Darkness into *unequal* Parts, the largest Parts of these *Circles* remaining in the *Light*, and the smallest in *Darkness*: But those *Parallels* that are towards the *South Pole*, as far as the *Circle* ua , have their greatest Portions in *Darkness*, and the least in *Light*; and the Difference of these Portions will be greater or less, according as the *Circles* are nearer to the Pole or to the *Equator*: Thus, in the *Parallel* of *London* LN , the *Diurnal Ark* is represented by Lc , and the *Nocturnal* by cN , in which Case the *Diurnal Ark* is greater than the *Nocturnal* to all those on the North Side of the *Equator*.

In like manner, the Earth being at z , the Point of its greatest *Southern Declination*, the Sun will then appear to the Northward from the *Equator* 23 Degrees 29 Minutes equal to the *Ark* of the *Meridian* $E\mathfrak{S}$, and the *Ray* of the Sun $S\mathfrak{S}$ shall meet with the

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Earth's Surface in $\odot$, from which a Line drawn *parallel* to the *Equator*, will represent the Parallel which the Sun appears to describe for that Day by the *Diurnal Motion* of the Earth, which *Circle* is call'd the *Tropick of Cancer*; and by the Revolution of the Earth round its *Axis*, all the Points of the *Parallel* $\odot \odot$, will pass directly under the Point $\odot$, therefore will be directly under the Sun, and the Sun will be *Vertical* to all the Inhabitants that are under the *Tropick of Cancer*, when he comes to their respective *Meridians*.

While the Earth is in this Position, it is manifest, that the *Circle* which bounds *Light* and *Darkness* reaches on the other Side of the *North Pole* P to y, but falls short of the *South Pole* O, and reaches no farther than u; thro' n y, and u s, let two *Parallels* of the *Equator* be described, these two *Circles* are called the *Polar Circles*, and while the Earth is in z, all that *Tract* of the *Globe*, that is included within the *Polar Circle* n y, continues in the *Light*, notwithstanding the *Revolution* of the Earth round its *Axis*, and the Inhabitants there enjoy a continued *Day*. On the contrary, those that lie within the opposite *Polar Circle* U S, remain in *Darkness*, having all Night without any Day.

It is likewise manifest, that all the *Parallels* between the *Equator* E Q, and the *Arctick Circle* n y, are cut by the *Horizon* y u into unequal Parts, the longest remaining in
Light,

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Light, and the shortest in *Darkness*. Thus, the Parallel of *London* L N, the *Ark* L c represents the *Diurnal*, and c N the *Nocturnal* Arch, therefore in this *Position* of the Earth, when the Sun is in ☊, the Inhabitants of the *Northern Hemisphere* will have their Days at the longest, and their Nights the shortest, and the Season of the Year will be *Summer*: But all those on the *South Side* of the *Equator*, will have their Nights the longest, and their Days the shortest, because the greatest Portion of their *Parallels* are in *Darkness*, and their least in the *Light*; the Season of the Year to them, at that Time will be *Winter*. And in every Place, the Length of the longest Days are greater, according as the Place is further removed from the *Equator*, and comes nearer to the *Pole*.

Also we see, that from the Time of the Sun's being upon the *Equator* at E, to the Time of his greatest *Declination* at ☊, the Sun has been continually in *View* of P, and O has been still in *Darkness*; that is, for the Space of three *Months*, answering to the three Signs γ, δ, η: Also the *Pole* P, has the Sun still in *View* during the following Months, while he describes the three Signs ☊, ♏, ♐, for all this while he is on the *North Side* of the *Equator*: And the *Circle* bounding Light and Darkness falls on the other Side of the *North Pole*, but short of the *South*; so that the Inhabitants of the *North Pole* (if there be any) have their Day half a Year long, and those of

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the *South Pole* half a Year Night, viz. from *March* 10. to *September* the 13th, and on the contrary, when the Sun is to the *South* of the *Equator*.

It is evident, that of all the *Parallels* there is only the *Equator* which is always cut into equal Parts by the *Circle* bounding *Light* and *Darkness*, being both of them great *Circles*; therefore it's only the *Inhabitants* of the *Earth* that live under the *Equator*, which have their *Days* constantly equal to their *Nights* throughout the whole *Year*.

While the *Earth* goes forward from $\bar{v}$ by $\approx$, and $\times$ to γ , during which Time the *Sun* seems to move through the *Signs* $\mathfrak{G}$, $\mathfrak{Q}$ and $\mathfrak{M}$, and returns towards the *Equator* till at last at $\approx$ the *Sun* appears in the *Equator* of the *Heavens*, because at that Time the Plane of the *Earth's Equator* produc'd does pass thro' the Center of the *Sun*, making the *Days* and *Nights* over all the *Earth* equal; and now again, the *Extremities* of *Illumination* reach to both *Poles*.

The *Earth* moving forwards through 'the *Signs* γ , δ , and Π , the *Sun* will appear in the mean while to go thro' $\approx$, $\mathfrak{M}$, and $\mathfrak{T}$, and to decline gradually from the *Equator* towards the *South Pole*, till at last the *Earth* being in $\mathfrak{S}$, and the *Sun* appearing in $\mathfrak{v}$, all the *Phænomena* will happen to the *Inhabitants* of the *Southern Hemisphere*, as happen'd to those of the *Northern*, when the *Earth* was in $\mathfrak{v}$, and
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what happened to those of the *Southern Hemisphere*, while the Earth was carried thro' ϖ , $\equiv$, and $\times$, will now happen to those of the *Northern*, while the Earth is carried thro' $\S$, Ω , III , and the Sun will seem to move through ϖ , $\equiv$, and $\times$, coming again to the Equator in γ , compleating the Year: And the Sun will cause the same *Phænomena* of Day and Night, the former decreasing, the latter increasing, to the Inhabitants of the *Southern Hemisphere*, as it did to the Inhabitants of the *Northern Hemisphere*, while it went thro' the opposite Signs.



S E C T. XV.

Of the ECLIPSES of the SUN and MOON.

THE Earth being an *Opaque* Body, and enlightened by the Sun, it casts a *Shadow* towards the Space opposite to the Sun; and because the *Figure* of the Earth is *Spherical*, the *Figure* of the *Shadow* would be *Cylindrical*; if the Earth and Sun were of equal Bigness, as in Plate 8. Fig. 19. or if the Earth were bigger than the Sun, the Shadow

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dow would have the *Figure* of a *Cone*, which had lost a Piece of its *Top* or *Vertex*, and the farther off from the Earth would be the *thicker*, (as in Fig. 20. Plate 8.) And in both these Cases the Shadow would be infinitely extended, and would *involve* sometimes the *Planets Mars, Jupiter, and Saturn* within it, when they come to be in *Opposition* to the Sun, but this is never *observed*, and therefore the Sun must be greater than the Earth, whose Shadow must be of a *Conical Figure*, and terminate in a Point, as in Fig. 21. Plate 8.

This Shadow of the Earth must always be in the Plane of the *Ecliptick*; since both Sun and Earth are always there. If at any time, when the *Moon* is in *Opposition* to the Sun, she should happen to be in the Plane of the *Ecliptick*, or pretty near it (which will be when the full Moon happens in or near a Node) it is evident that the Moon will be immersed in the Earth's Shadow, and consequently deprived of the Sun's Light, (as in Plate 9. Fig. 22.) by which it *shines*, that is, it will *suffer* an *Eclipse*, which will be *total* or *partial*, as a Whole, or only a Part of the *Moon's* Body enters the Shadow.

Let the Line xy (Fig. 22. Plate 9.) represent the *Transverse Section* of the Earth's Shadow, where it crosses the Moon's *Orbit*. Let $\odot A \oslash B$, be the *Orbit* of the Moon, $\odot C \oslash E$ the *Ecliptick*, the Duration of some *Eclipse* is found to be so long as to let the Moon go the Length of 3 of its Diameters in the

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the Shadow totally *eclipsed*, which Stay in the Earth's Shadow is computed to be about four Hours, whereof the Moon takes one Hour from its *Beginning*, to enter the Shadow, till quite *immersed* therein, two Hours more she continues *totally dark*, and the fourth Hour is taken up from her first *Beginning* to come out of the Shadow, till she is quite out of it: And such an *Eclipse* is called a *Total* and *Central Eclipse*.

Sometimes the Moon is not arrived at, or has already passed the *Node*, when it is entering the Earth's Shadow; notwithstanding, if at that time it be near the *Node*, it will be *totally immersed*, and consequently there will happen a *Total*, though not a *Central Eclipse*, (as in Fig. 23. Plate 9.) for the Way of the Moon A B, thro' the Earth's Shadow CD, is shorter than the *Diameter* of the Shadow E P, because it does not pass thro' its *Center*, and consequently will be passed thro' sooner.

But if it be so far off from the Shadow, as that only part of the Moon is *immersed*, as it passes in its Orbit (y x Fig. 24. Plate 9) the Shadow PO, the *Eclipse* will be a partial one, and is said to be of so many Digits, as there are twelfth Parts of the Moon's *Diameter* darkened.

In all these Cases, in the Beginning of an *Eclipse*, the Moon enters the *Western* Part of the Shadow with the *Eastern* Part of her Limb, and in the End of it she leaves the *Eastern* Part of the Shadow with the *Western*

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Part of her Limb. The *Eastern* Limb, of the Moon in its Access to the Shadow, does not enter presently into the thickest *Darkness*, but grows darker and darker as it approaches *nigher* to the Shadow, and this arises from the *Penumbra*, which always accompanies a Shadow, which is made by a *lucid* Body that is seen under a sensible Angle, thus (Fig. 21. Plate 8.) $x y A z$, represents the Shadow (where no Part of the Sun's Light comes) which is encompass'd all round with the *Penumbra* $Y X P A Z$, where only some Part of the Sun's Light is intercepted by the Earth, and this *Penumbra* is more dim towards $x y$ and $z A$, the Edges of the perfect Shadow, because fewer Rays arrive thither; the *Portion* of the Sun, from which they are emitted, being smaller, but less *obscure* towards $x P$, and $Z N$, where more Rays can reach, and beyond which *Limit* all the Rays of the Sun can come without any Hindrance at all.

Some kind of *Eclipse* or other of the Moon happens generally twice a *Year* at least, for there being two *Nodes*, in which the Moon's *Orbit* crosses the *Ecliptick*, which move contrary to the Series of the *Signs*, and the Earth going round the *Ecliptick* every *Year*, according to the Order of the *Signs*; hence it is obvious, that the Earth must meet the Moon's *Nodes* every *Year*. If therefore a Full Moon happens *just* at that Time, the Moon must necessarily be *totally* and *centrally eclipsed*; and
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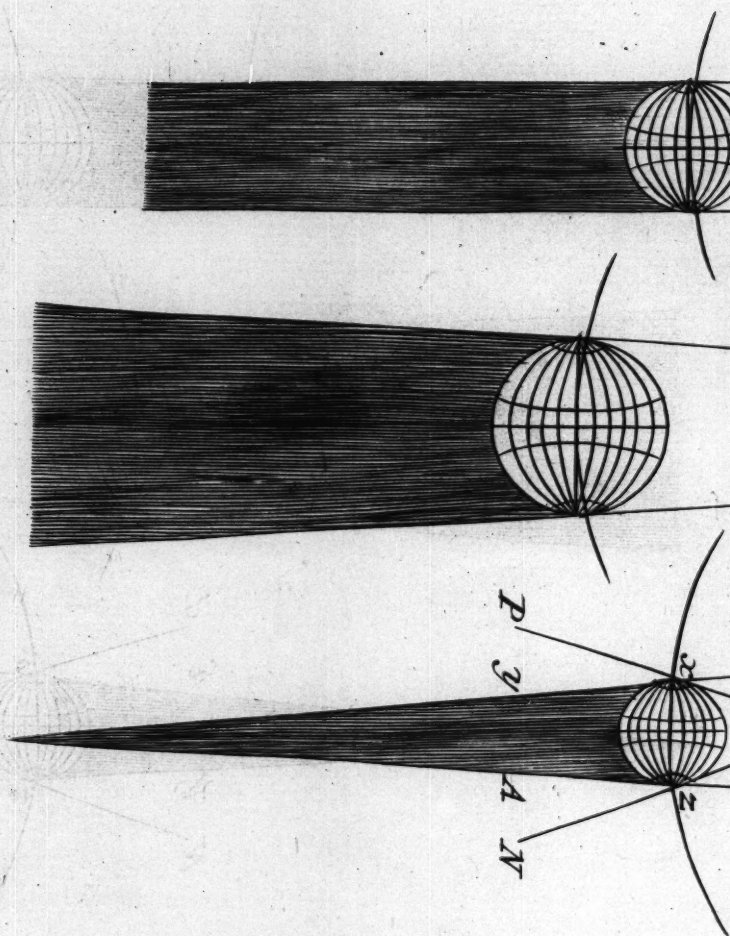


Plate 8.

Fig. 19.

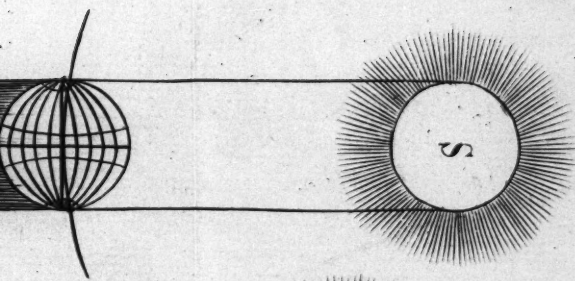


Fig. 20.

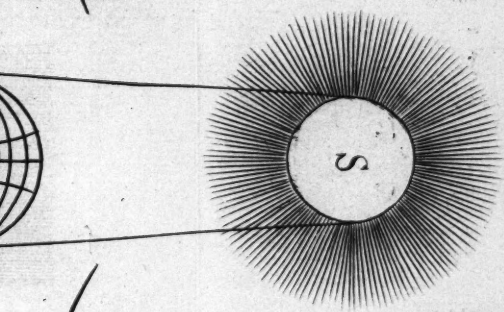
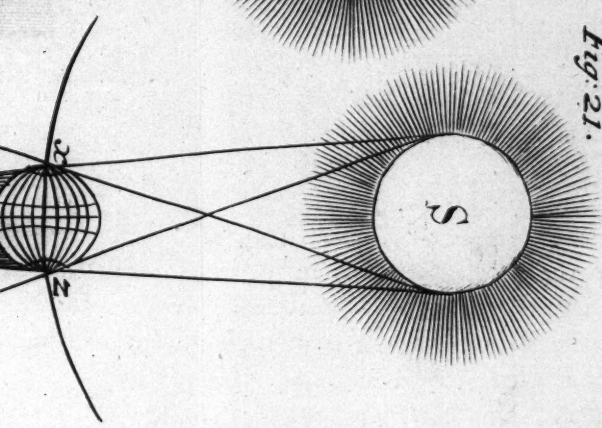


Fig. 21.



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though a Full Moon does not happen *just* as the Sun and Node meet, yet the *Inclination* of the *Orbit* of the Moon to the *Ecliptick* is so little, and the Depth of the Earth's Shadow is so great, that tho' the Full Moon is distant above ten Days from the Time of the Sun's appearing in that Degree of the *Ecliptick*, in which the Node is at that Time, either before or after it, and it cannot be distant above *fifteen* Days, yet the Moon will scarce get *clear* of the Shadow, and consequently there will be at least a *partial Eclipse*. But if the Earth happens to meet a *Node* of the Moon, on the very Day of the *New Moon*, or one or two Days before or after, (which rarely happens) in this Case the *Moon* will be far enough to avoid the Shadow of the Earth, both in the foregoing and also in the following *Full Moon*, and so there will be no *Eclipse* of the Moon that half Year.

The *Moon* also being an opaque *Body*, and enlightened by the Sun, consequently casts a Shadow towards those Parts that are turned from the Sun. And if the Earth should be deprived of the Sun's Light, by being *immersed* in the Shadow of the *Moon*, this *Phænomenon* ought to be called an *Eclipse* of the *Earth*: But the Observer of it being on the *Earth*, and the *Moon* (which more or less covers the Sun) not being easily perceived by us, the Defect of Light *appears* to us as in the Sun it-self, and is therefore called an *Eclipse* of

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of the *Sun*, which is also *distinguish'd* into a *Total Eclipse*, wherein the Moon covers the whole Body of the Sun from us, or a *partial Eclipse*, wherein the Moon covers only a Part of the Sun.

But it is to be *observed*, that altho' an *Eclipse* of the Sun be, in reality, an *Eclipse* of the Earth, yet what is called a *Total Eclipse* of the Sun, is not to be conceived in reality, as a *Total Eclipse* of the Earth, or that the whole upper and *opposite Hemisphere* of the Earth is then deprived of the Sun's Light, as in a *Total Eclipse* of the Moon its whole *opposite Hemisphere* is *darkened*. The Reason of which *Difference* is this: The Earth being bigger than the Moon, the Cone of its Shadow is big enough to involve the whole *opposite Hemisphere* of the Moon in its Darkness, whereas the Moon being less than the Earth, the Cone of her Shadow will involve at once, only a small Tract A B (in Fig. 25. Plate 9.) of the *opposite Hemisphere* of the Earth, so as to hide the whole Sun from the Inhabitants thereof, and consequently there will appear only to these a *Total Eclipse* of the Sun, whilst to the Inhabitants of the adjoining Tract B C, the Sun will appear to be but *partially eclipsed*; at the same Time in other Places of the same *Hemisphere*, as E F, there is no *Eclipse* at all, the Sun enlightening without any Hindrance or *Impediment*.

The

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The Height of the Moon's Shadow may be found by *Calculation*, to be about 59, 36 *Semidiameters* of the Earth; hence, if the Distance of the Moon from the Earth be greater than her Mean Distance 60 Diameters of the Earth, the Shadow of the Moon cannot reach the *Earth*, in which Case there may be a *Central Eclipse* of the Sun, but not a *Total* one, but round the Moon there will appear a Part of the Sun's Body in the Form of a *luminous Circle*, which like a bright *shining Ring of Gold*, will embrace the *Body* of the Moon.

The Bigness of a *Solar Eclipse* is to be estimated the same Way as in a *Lunar Eclipse*, by the Digits, or 12th Parts of the Sun's *Diameter* that are *darken'd* by the Moon, at the middle Time of an *Eclipse*.

It is likewise evident that the Moon moving towards the *East* (as in Fig. 25. Plate 9.) the *Western* Part of the Earth will be in the Shadow first; which will pass along the Earth's *Disk* like a Spot, thro' A B C E to F, where it leaves the Earth; but if the Moon be viewed from the *Earth*, the *Eastern Limb* of the Moon will first cover the *Western* of the Sun, and the *Western Limb* of the Moon will last uncover the *Eastern* of the Sun, and the greatest *Darkness* that can happen in a *Total Eclipse* of the Sun, is soon at an End, some Part of the Sun's *Disk* being presently uncovered, and that Part, tho' never so little, will mightily enlighten those Inhabitants of the

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the Earth, to whom it is visible. Tho' the Moon must be in a *Node* the very Moment of the *New Moon*, to cause the greatest *Eclipse* of the Sun that can happen; and that the Shadow of the Moon may go along the Middle of the Earth; yet, if she be not far off from thence, the Shadow of the Moon, or at least Part of the *Penumbra*, will fall upon some Tract of the Earth, (by reason of the Bigness of the Earth) so as to cause there a *Total*, or at least a *Partial Eclipse*; and in this Sense there are more *Eclipses* of the Sun than of the Moon, but in respect of any one given Place of the Earth, there are much fewer *visible Eclipses* of the Sun than of the Moon, for the Shade of the Moon is less than the Shade of the Earth, and consequently the former will not so often *involve* any given Place of the Earth, as the latter will some Part of the Moon.



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Fig. 25.

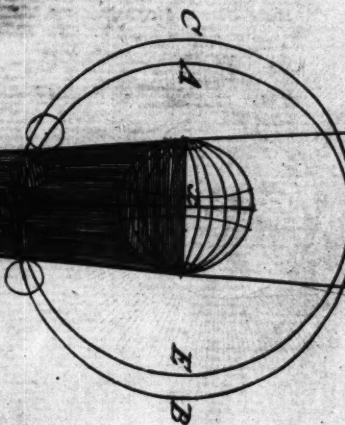
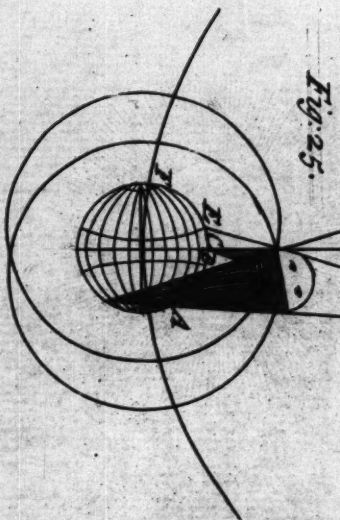


Fig. 24.

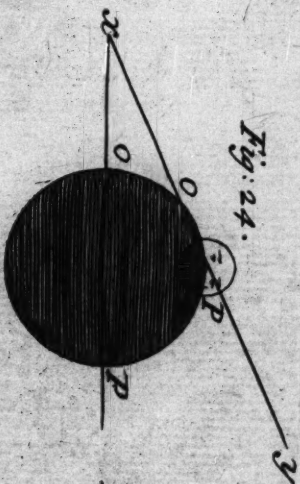


Fig. 23.



Fig. 22.

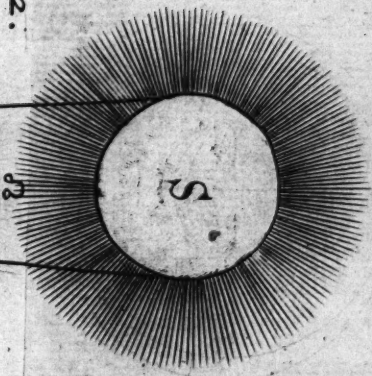
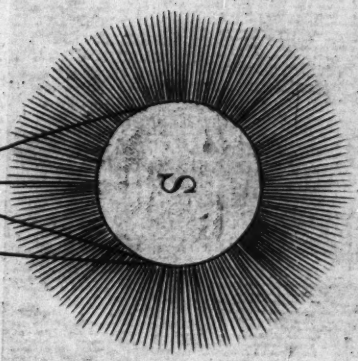


Fig. 25.



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SECT. XVI.

*Of the Solution of SPHERICAL TRIANGLES
upon the GLOBE.*

S*Spherical Triangles* are best represented by the *Circles* on, and those *appendant* to the *Globes*: The *Globe* being the *Original* from whence all *Spherical Trigonometry* proceeds, and upon which the *Sides* and *Angles* of all *Spherical Triangles* are most naturally represented and most expeditiously measured.

Definition I. A *Spherick Triangle* is bounded by the *Arks* of Three great *Circles* of the *Sphere*, or *Globe*, each *Ark* being less than a *Semicircle*, or 180° .

Def. II. A *Spherick Angle* is the same with the *Inclination* of the *Planes* of those two *Circles* which constitute the *Angle*; and if from the *Point* of any *Spherick Angle* as a *Pole*, you describe a *Circle* at the *Distance* of 90° from that *Point*, the *Arch* of this *Circle* intercepted between the *Legs* of the *Angle*, is the *Measure* of it.

Def. III.

Def. III. When a *Spherical Angle* has one or more *Right Angles*; that is, contains 90 Degrees, it is call'd a *Right-angled Spherical Triangle*: If all its Angles be acute, that is, each of them less than 90 Degrees, it is call'd an *Acute Angled Triangle*; and if all its Angles be *obtuse*, each exceeding 90 Degrees, or if some of them be *obtuse* and some *acute*, it is called an *Obtuse Angled Spherical Triangle*.

Def. IV. The *Complement* of a Side or Angle to a *Quadrant*, or 90 Degrees, is so much as that Side or Angle wants of 90 Degrees; and their *Complement* to a *Semicircle*, is so much as that Side or Angle wants of 180 Degrees.

Def. V. If two great *Circles* of the *Sphere* pass through each other's *Poles*, those two great *Circles* intersect each other at *Right Angles*; but if they intersect each other, and do not pass through each other's *Poles*, those two *Circles* shall intersect each other at *Oblique Angles*.

Def. VI. If a *Spherical Triangle* have three *Right Angles*, the three Sides of that *Triangle* shall be all *Quadrants*, as in a *Parallel Sphere*, the *Brass Meridian* cutting the *Horizon* in *North* and *South* at *Right Angles*, the *Equinoctial Colure* cutting the *Horizon* in the *E.* and *W.* Points at *Right Angles*; and the

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the *Meridian* and *Colure* intersecting each other in the Poles of the *World* at Right Angles; do constitute a *Spherical Triangle* with three Right Angles; and the three Sides of this *Triangle*, for this Reason, shall be all of them *Quadrants*.

Def. VII. The Sides of *Spherical Triangles* are of the same Affection or Kind with their opposite Angles.

Def. VIII. All great *Circles* must cut each other in two equal Parts, because their common Intersection is a *Diameter* of the *Sphere*, and consequently the two Points of Intersection are at the Distance of a *Semi-circle* from each other.

Def. IX. The opposite *Angles*, at the Intersection of two *Circles*, are always equal, because the same *Plane* constitutes both *Angles*.

CASE I.

In the *Right Angled Triangle* H O P,
Right Angled at H, Fig. Plate 10.

Given

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$\left\{ \begin{array}{l} \text{P H the Latitude of} \\ \text{the Place - - - - -} \end{array} \right\} 51^{\circ} 30'$
 Given $\left\{ \begin{array}{l} \text{P O the Sun's Distance} \\ \text{from the Pole, or the Com-} \\ \text{plement of his Declination} \end{array} \right\} 70^{\circ} 30'$

Required $\left\{ \begin{array}{l} \text{H O the Complement of the} \\ \text{Sun's Amplitude.} \\ \text{H P O the Hour of the Sun's} \\ \text{Rising accounted from Mid-} \\ \text{night.} \\ \text{P O H the Angle of the Sun's} \\ \text{Position.} \end{array} \right.$

To represent this Triangle on the GLOBE.

Elevate the Pole to the given *Latitude*, and turn the *Globe* about till $70\frac{1}{2}$ Degrees of the *Equinoctial Colure*, counted from the *Pole*, be at the *Horizon*; so will the *Triangle* be perfectly described by an *Arch* of the *Brass Meridian*, an *Arch* of the *Horizon*, and an *Arch* of the *Colure*.

The Complement of the Sun's *Amplitude* H O, is numbered on the *Horizon*, from the *Colure* to the *North Point* of the *Horizon*, and in this Case is $57^{\circ} 34'$.

For the Angle H P O, count the Degrees of the *Equinoctial*, which are contained between the *Colure* and the *North Side* of the *Brass Meridian*, which Degrees reduced to Time, by allowing 15° to an *Hour*, give the

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the Time of Sun-rising, and in this Case will be 62 Deg. 45 Min. or 4 Hours 11 Minutes; the Hour from *Midnight*.

And for the Angle P O H, number on the *Colure*, and also on the *Horizon* (the Sides that include the Angle) 90 Degrees from the *Angular* Point, and the Distance between those two Points, where the Reckoning ends, measured by the *Quadrant* of *Altitude*, or by *Compasses*, contains 56 Deg. 39 Min.

C A S E II.

In the Right-angled *Triangle* x y z, *Right-Angled* at y, Fig. 2. Plate 10.

Given $\left\{ \begin{array}{l} x z \text{ the Sun's Distance} \\ \text{from the next } \textit{Equinoctial} \\ \text{Point } \textit{Aries} \text{ - - - - -} \end{array} \right\} \begin{array}{l} 0 \\ 72 \\ 00 \end{array}$

$\left\{ \begin{array}{l} y x z \text{ the Angle that the} \\ \textit{Ecliptick} \text{ makes with the} \\ \textit{Equator}, \text{ being the Sun's} \\ \text{greatest Declination - - -} \end{array} \right\} \begin{array}{l} \\ 23 \\ 29 \end{array}$

Required $\left\{ \begin{array}{l} z y \text{ the Sun's present Declina-} \\ \text{tion} \\ x y \text{ the Sun's Right Ascension,} \\ y z x \text{ the Angle that the } \textit{Meri-} \\ \text{dian} \text{ makes with the } \textit{Ecliptick}. \end{array} \right.$

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To represent this Triangle on the GLOBE.

Bring the Sun's Place (which in this Example is the 12th Degree of *Gemini*) to the brazen *Meridian*, and fix the *Globe* in that Position, and the *Triangle* will be represented by an *Arch* of the *Equator*, an *Arch* of the *Ecliptick*, and an *Arch* of the brazen *Meridian*.

The Sun's present Declination $z y$ is measured on the brazen *Meridian*, and in this Case is $22^{\circ} 16'$.

The Sun's Right Ascension $x y$ is measured on the *Equator*, and from the first of *Aries*, and in this Case is 70 Deg. 29 Min.

And for the Measure of the Angle $y z x$, number 90 Degrees on the *Meridian* from the Sun's Place, and 90 Degrees on the *Ecliptick* from the same Place, so shall the Distance between these Points (measured by the *Quadrant* of *Altitude*, or by *Compasses*) contain for the Angle $y z x$, 82 Deg. 20 Min.

CASE III.

In the Right Angled *Spherical Triangle* A O B, Right Angled at B, Fig. 3. Plate 10.

Given

Given $\left\{ \begin{array}{l} \text{O A B the Comple-} \\ \text{ment of Latitude} - - - \end{array} \right\} 38^{\circ} 30' \text{ N.}$
 $\left\{ \begin{array}{l} \text{B O the Sun's Decli-} \\ \text{nation North} - - - - \end{array} \right\} 20^{\circ} 30'$

Required $\left\{ \begin{array}{l} \text{A O the Sun's Amplitude from} \\ \text{the East or West Points of the} \\ \text{Horizon.} \\ \text{A B the Ascensional Difference.} \\ \text{A O B, the Angle of the Sun's} \\ \text{Position at his Rising.} \end{array} \right.$

To represent this Triangle on the GLOBE.

Depress the *Equator* below the *North* Point of the *Horizon* $38^{\circ} 30'$, the Complement of the *Latitude*, then number the Sun's Declination 20° Deg. $30'$ Min. on the *Equinoctial Colure*, and bring that to the *East* Side of the *Horizon*; so shall the *Triangle* be formed, and appear below the *Horizon*, by A O, an *Arch* of the *Horizon*, A B an *Arch* of the *Equinoctial*, and B O an *Arch* of the *Colure*.

The Parts required of this Triangle are found thus:

A O the Sun's *Amplitude* from the *East*, is numbered on the *Horizon* to the *Colure*, and is 34° Deg. $14'$ Min.

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A B the Ascensional Difference is numbered on the *Equator*, from the *East Point* of the *Horizon* to the *Colure*, and is 27 Deg. 18 Min.

And the Angle of the Sun's *Position* A O B is found by continuing the Sides O A and O B, to *Quadrants*, and then measuring betwixt those two Points, as in the first and second Cases.

CASE IV.

In the *Right Angled Triangle* A E L, *Right Angled* at E, Fig. 4. Plate 10.

Given $\left\{ \begin{array}{l} \text{A L the Sun's Decli-} \\ \text{nation - - - - -} \end{array} \right\} \begin{array}{l} 20 \\ 30 \end{array} \text{ N.}$
 $\left\{ \begin{array}{l} \text{L A E the Latitude -} \\ \text{- - - - -} \end{array} \right\} \begin{array}{l} 51 \\ 30 \end{array} \text{ N.}$

Required $\left\{ \begin{array}{l} \text{L E the Sun's Altitude at Six.} \\ \text{A E the Sun's Azimuth from} \\ \text{the East.} \end{array} \right.$

To represent this Triangle on the GLOBE.

Elevate the *Pole* to the given *Latitude*, fix the *Quadrant* of *Altitude* in the *Zenith*, and number the Sun's Declination 20 Deg. 30 Min. on the *Equinoctial Colure*; the *Colure* being brought to the *East Point* of the *Horizon*, bring the graduated *Edge* of the *Quadrant* over the Sun's Declination on the *Colure*:

lure: So will the *Triangle* be formed by A L, an *Arch* of the *Colure* equal to the Declination A E, an *Arch* of the *Horizon*, equal to the *Azimuth* numbered from the East: And,

L E an *Arch* of the *Quadrant* of *Altitude*, in which Case L E, the Sun's *Altitude*, is 15 deg. 54 min.

A E the Sun's *Azimuth* from the East 13 deg. 6 min.

Of Oblique Angled SPHERICAL TRIANGLES.

CASE I.

In the *Oblique Angled Spherical Triangle* P Z M (Fig. 5. Plate 10.) *Obtuse* Angled at Z.

Given	{	Z P the Complement	}	38	30
		of the <i>Latitude</i> - - - -			
		M P the Sun's Distance	}	70	00
		from the <i>Pole</i> , being the Complement of his Declination - - - - -			
	{	M Z the Complement	}	47	20
		of the Sun's <i>Altitude</i> , or his Distance from the <i>Zenith</i> - - - - -			

P 3

Required

Required. $\left\{ \begin{array}{l} \text{P Z M the Sun's Azimuth.} \\ \text{Z P M the Hour of the Day.} \\ \text{Z P M the Sun's Angle of Position.} \end{array} \right.$

To represent this Triangle on the GLOBE.

Elevate the *Pole* to the *Latitude*, then count Z P 38 Deg. 30 Min. the Complement of the *Latitude* from the *Pole* on the *South* Side of the brazen *Meridian*, and where the Reckoning ends, skrew the *Quadrant of Altitude*; this done, count the Side M P 70 Deg. upon the *Equinoctial Colure* from the *Pole*, and the Side Z M upon the *Quadrant of Altitude* from the *Zenith* downwards, and so move the *Globe* and *Quadrant of Altitude* together, till the Numbers counted on the *Colure* and *Quadrant of Altitude* meet in one Point; so will the *Triangle* be exactly delineated upon the *Globe*.

Now to find the several Angles.

For the Angle at Z, count the Number of Degrees of the *Horizon*, which are contained between the *North* Point of the *Meridian* and the *Quadrant of Altitude*, which you will find to be 115 Deg. 35 Min. the Sun's *Azimuth* from the *North*.

For the Angle Z P M, number the Degrees of the *Equator* contained between the
South

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South Part of the brazen *Meridian* and the *Colure*, which you will find to be 45 Deg. which reduced to Time is 3 Hours, the *Hour* from *Noon*; namely, 9 in the *Morning*, or 3 in the *Afternoon*.

For the Angle Z M P, the Angle of the Sun or Stars Position at the Time of the Question; count 42 Deg. 48 Min. the Complement of M Z, upon the *Quadrant* of *Altitude* (it being brought to the other Side of the *Meridian*, and also count 20° the Complement of M P on the *Colure* (on the other Side of the *Meridian*) the Distance of these two Points, measured with a Pair of *Compasses* or otherwise, gives 36 Deg. 52 Min. which is the Angle of the Sun's Position.

So that by the Knowledge of the *Latitude* of the Place of *Observation*, the *Altitude* and *Declination* of the Sun or Star, the exact *Hour* of the *Day* or *Night* may be known, and the *Azimuth* of the *Celestial Phænomenon*.

Also by having any three Parts of the *Triangle* given, the other three may be found, which affords a great many *Varieties* or *Cases*, in every *oblique-angled spherical Triangle*.

This *oblique-angled spherical Triangle* may also be applied to *Geographical* or *Nautical* Questions; for

The Side Z P may represent the Complement of the *Latitude* of that City, whose *Zenith* Point is Z.

The Side P M will be the Complement of the *Latitude* of the City or Town at M.

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The Side Z M may represent the Distance between those two Cities.

The Angle P Z M is the Difference of Longitude between the two Cities M and Z.

The Angle M P Z, the Point of the Compass leading from M to Z.

The Angle P M Z, the Point of the Compass leading from Z to M.

From which it is evident that, if you observe the *Bearing* or Course from Z to M, the Reverse of that Course will not carry from M to Z, which makes good the *Geographical Paradox*, that a Place may lie *East* of *London*, and *London* not lie *West* of that Place.

Moreover, in the same *Triangle* you may make the Side Z P, the Distance of the *Pole* of the *Equator* from the *Pole* of the *Ecliptick*: Then P M will be the Complement of the *Declination* of a Star at M, the Side Z M will be the Northern *Latitude* of that Star; the Angle M P Z, will be the Complement of the Star's *Right Ascension*, the Angle P Z M, the Quantity of the Star's *Longitude*, and the Angle P M Z, the Angle of the Star's Position.

There are divers other *Triangles* both right and oblique angled; but these, as the most particular, I recommend to the Practice of the *Learner*, which, if well understood, will enable him to proceed to a farther Use of the *Globes*, as applied to *Gnomonical Problems*.



SECT. XVII.

*Of the Practical Use of the GLOBES
in the Solution of Gnomonical Problems.*

AMong the *various* pleasing and profitable Amusements which arise from the Use of the *Globes*, that of *Dialling* is not the least, because it rewardeth those that incline to exercise themselves that Way, with abundance of Pleasure, and is of universal Use to Mankind in determining the *Periods* of Time allotted for *Business*, *Company*, or *Retirement*, &c.

The *Ancients* being sensible of this *Advantage*, invented several Ways whereby they might distinguish and observe the *Hours* either by *Day* or *Night*, but none with less *Charge* or greater Certainty answered their Design, than Sun-Dials drawn upon the Superficies of fixed *Bodies*. And the whole *Art* of *Dialling* being most naturally and clearly *illustrated* by the Help of *Spheres* or *Globes*, we shall in this Section consider those *Kinds* of *Dials* only,

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only, which may easily be constructed by the *Globes*, and drawn upon plain Superficies, which being thoroughly understood as a Foundation, any Person acquainted with *Arithmetic* and *Geometry*, will easily conceive how all other Kinds of *Dials* may be drawn, whether by *Lines* or *Numbers*.

1. Every *Dial-Plane* (i. e.) plain Surface on which a *Dial* is drawn) represents the Plane of some great *Circle*, which Circle is an *Horizon* to some Country or other. The *Center* of the *Dial* representeth the *Center* of the Earth, and the *Gnomon*, which casteth the Shade, representeth the *Axis*, and ought to point *directly* to the *Poles* of the *Equator*.

2. All *Planes* upon which *Dials* are made in any *Latitude*, do either lie, 1st, *Parallel* to the *Horizon*: or, 2^{dly}, are perpendicular to the *Horizon*: or 3^{dly}, do cut the *Horizon* at *Oblique* Angles.

3. A Plane that lieth parallel to the *Horizon*, is said to be an *Horizontal*, or by some called a *Vertical Plane*.

4. Of Planes that are perpendicular to the *Horizon*, there are two *Varieties*; for,

First, if they are parallel to the *East* and *West Azimuth*, and so stand directly *North* and *South*, or *parallel* to the *Meridian*, and
behold

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behold the *East* and *West*; such are called *Direct Vertical Planes*.

Secondly, If they stand in any other *Azimuth*, and are *Perpendiculars* to the *Horizon*, then they are called *Vertical Planes*, declining from the *North* or *South*.

5. Of *Planes* that cut the *Horizon* at *oblique* Angles, there are several *Varieties*, as shall be shewn, when we come to consider *inclining* and *reclining Dials*.

P R O B. I.

To make an Horizontal Dial.

The Operation by the GLOBE.

Elevate the *Pole* to the *Latitude* of the Place for which you would make your *Dial* (suppose to *London*, in the *Latitude* of $51^{\circ} 30'$) and bring the *Vernal Colure* to the *Meridian*, and the *Hour Index* to 12 on the *Hour Circle*.

And turning the Globe Westwards, till the In- dex point to	{	$\begin{matrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{matrix}$	}	a Clock, or till 15° of the Equator pass through the Meridian, and the Colure will cut the Horizon in	{	$\begin{matrix} 11^{\circ} & 50' \\ 24 & 20 \\ 38 & 03 \\ 53 & 36 \\ 71 & 06 \\ 90 & 00 \end{matrix}$	}	From the Me- ridian.
--	---	--	---	---	---	---	---	----------------------------

These are the *Distances* of the *Hour-Lines* from *Noon* till 6 at *Night*, and the same *Distances* serve for the *Hours* betwixt 6 in the *Morning*,

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Morning and 12 at *Noon*, for the one a *Clock Hour-Line* in the Afternoon is equidistant from the *Meridian*, or *Noon-Line*, with the 11 a *Clock Hour-Line* before *Noon*, and so all the other *Morning Hour-Lines* are distant from the *Noon-Line* by the same Space that the same Number after *Noon-Hour-Lines* (numbred from the *Meridian* on the contrary Side of the *Noon-Line*) are distant from the *Meridian*.

If you would have the half *Hour-Lines* plac'd on your *Dial*, you must turn the *Globe* till the *Index* points to every half *Hour* on the *Hour-Circle*, and mark the Degrees of the *Horizon*, cut by the *Vernal Colure*, for those are the Degrees belonging to the half Hours required.

The Geometrical Construction of this D I A L.

1. Upon the Plane on which you design to draw your *Dial* (as in Plate 11. Fig. 3.) draw a right Line A B, representing the *Meridian* of your *Globe*, and the *Hour-Line* of 12.

2. Towards one End of this Line, assign a Point C, representing the Center of your *Dial*, and through that Point draw another Line at *Right Angles* to A B, which shall be the *Hour-Line* at 6, as the Line K M; and upon the Point C, with the *Radius* of some Line of *Cords*, describe a Semicircle D E F.

3. Then

3. Then seeing 11 and 1 a Clock are distant from the *Meridian* 11 Deg. 50 Min. take 11 Deg. 50 Min. from your Line of *Chords*, and set it upon the Semicircle from E to 11, and from E to 1, and draw the Lines C 11, and C 1, for the Hour-Lines between 11 and 1.

4. The Distance of 10 and 2, being 24 Deg. 20 Min. take from your Line of *Chords* 24 Deg. 20 Min. and set it from E to 10, and from E to 2, and draw the Hour-Lines of 10 and 2; do thus with the rest of the Hour-Lines, till 6 in the *Morning* and 6 at *Night*; and for the Hour-Lines of 4 and 5 in the *Morning*, and of 7 and 8 at *Night*, continue the Hour-Lines of 4 and 5 in the *Afternoon* thro' the Center to the other Side of the *Dial*, and they will be the Hour-Lines of 4 and 5 in the *Morning*; and the Hour-Lines of 7 and 8 in the *Forenoon* continued, will be the Hour-Lines of 7 and 8 in the *Afternoon*.

5. For the Style or Cock of your *Dial* take 51 Deg. 30 Min. the Latitude from your Line of *Chords*, and set that Distance upon the *Semicircle* from E to G, and draw the Line CG for the Style, which must stand upon the Line of 12, without inclining to the *East* or *West*, and so is your *Dial* finished.

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P R O B. II.

To make an Erect South Dial for Latitude
31 Degrees 30 Minutes.

The Operation by the Globe.

You may reduce all *Verticals* to *Horizontals*, if you elevate the *Pole* to the Complement of the Latitude, which in this Case is 38 Deg. 30 Min. and bring the *Vernal Colure* to the *Meridian*, and the *Index* to 12, then turn the *Globe Westwards*, and as each 15th Degree is at the *Meridian* (or as the *Index* points out the several Hours on the *Hour-Circle*) the *Colure* shews in the *Horizon* the Distance of the several Hour-Lines, from the *Meridian*, as in the following Table.

Comp. Latitude 38° 30'.			
Hours.		Distances from the <i>Meridian</i> .	
	12	00°	00'
11	1	09	28
10	2	19	45
9	3	31	54
8	4	47	09
7	5	66	42
6		90	00

The

The Geometrical Construction, Plate II.

Figure 2.

1. Draw a *Meridian-Line*, as L M, for the Hour-Line of 12, *cross* it at *Right Angles* with the Line N P for the Hour-Line of 6, and 6, and where these Lines *cross* each other (as at O) is the Center of the *Dial*.

2. With the *Chord* of 60 Deg. draw a Semicircle N P Q, and from the Line of *Chords* take the Hour Distances (as in the above Table) from the *Meridian*, and lay on the Semicircle one Foot of the Compass being in the *Meridian*; thro' which Distances, from the Center, draw the Hour-Lines, as in Prob. 1.

3. For the Style, take 38 Deg. 30 Min. (the Complement of that *Latitude*) from the Line of *Chords*; set it from Q to R, and draw the Line O R for the Cock or Style of your *Dial*, which must stand over 12, and point downwards towards the *South Pole*.

N. B. The *North Vertical Dial* is the same with the *South*, only the Style must point upwards, towards the *North Pole*, and the Hours 9, 10, 11, 12 at Night, and 1, 2, 3 in the Morning must be left out, and 4, 5 in the Morning, and 7, 8 at Night, must be drawn through the Center, so is your *North Dial* finished.

P R O B.

P R O B. III.

To make an Erect, Direct East or West DIAL.

These Sorts of *Dials* may be better *demonstrated* than made by the *Globe*, for the *Pole* being rectified to the *Latitude*, the Index to 12, and the *Quadrant* of *Altitude* in the *Zenith*; if the *Quadrant* be brought about till the graduated *Edge* thereof be exactly *East* or *West*, and turning the *Globe* about, the *Equinoctial Colure* will not cut the *Quadrant* of *Altitude* in any particular Degree, but a Part of the *Colure* will coincide with all the Degrees of the *Quadrant* at the same Time; wherefore the Hour Lines of these *Planes* will make no Angles at the *Pole*, and consequently must be parallel to one another, which the *Globe* plainly represents, but will not conveniently give the *Parallel* Distance of each from the other, they being nearer or farther off, according as the *Style* is proportioned to the *Plane*.

The Geometrical Construction.

Let the Plan, upon which you would make an *East* or *West Dial*, be A B C D, Plate 11. Fig. 3.

1. Upon D, if it be an *East Dial Plane*; or upon the Point C, if it be a *West Dial*, with

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with the Radius of your Line of *Chords*, describe an *Arch* of a Circle *G F*, then from your Line of *Chords* take 38 Deg. 30 Min. and draw the Line *D G E* quite through the Plain for the *Equinoctial*, towards the upper Part of this Line, as at *P*; assume any Point, and through it draw the Line *6 P 6*, perpendicular to the *Equinoctial* for the Hour-Line of six, also towards the lower Part of the same Line, assume another Point as *L*, and through it draw the Line *11 C 11*, for the Hour of Eleven.

2. With 60 Deg. from your *Chords*, upon the Point *C*, describe a small *Arch* of a Circle as *H K*, and upon it set 15 Degrees, or one Hour's Distance from *H* to *K*, and draw the Line *C K M*, cutting the Hour-Line of 6 in *M*.

Upon *M* as a Center, with 60 Deg. from your *Chords*, describe an *Arch* of a Circle *N O*, which divide into five equal Parts in the Points *O O O*, &c. Lay a Ruler upon *M*, and each of these Points, and the Ruler will cut the *Equinoctial Line D E* in the Points ***, through which Points, if you draw right Lines parallel to the Hour-Line of 6, they will be the Hour-Lines of 7, 8, 9 and 10, the Hour-Lines of 6 and 11 being drawn before.

For the Hour-Lines of 4 and 5 in the Morning, they retain the same Distance from six, as do the Hours 8 and 7.

Q

The

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The *Style* must stand upon the Hour-Line of 6, and be in Height equal to the Length of the Line M P, and may be either a Pin or Wire, or a Plate of *Brass*, or *Iron*.

An Erect, Direct West Dial is the same in all respects with an Erect, Direct East Dial, only as the East shews the Forenoon Hours, the West shews the Afternoon Hours, for that which is in the East-Dial is 10, the West Dial must be 2; and 9 in the East Dial must be 3 in the West.

P R O B. IV.

Of erect Declining Planes.

The upright or erect Planes that we have hitherto treated of, are such as do directly behold the four *Cardinal Points* of the Horizon, all other upright Planes are said to decline, and their Declination is counted from the North or South, towards the East or West; thus to make an *erect Dial* for 51 Deg. 30 Min. North, the Plane declining from the North towards the East, 63 Degrees: Elevate the Pole to the given Latitude, fix the Quadrant of Altitude to the Zenith, and number the Declination of the Plane upon the Horizon from the North, (or South Point thereof according as the Plane declines) namely, 63 Deg. and to that Point of the Horizon bring the Quadrant of Altitude, and there fix it, then bring the Vernal Colure to the Meridian,

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dian, and the Index of the Hour Circle to the uppermost Figure of 12, in the Hour Circle; then turn the Globe Eastwards, till the Index points to all the Hours before Noon; and examine in what Number of Degrees from the Zenith the Colure cuts the Quadrant of Altitude, when the Index points to each Hour, or when each 15 Degrees of the Equator passes the Meridian, for the Degrees of the Quadrant, numbered from the Zenith, cut off by the Colure, are the Distances of the Forenoon Hour-Lines, as are expressed in the following Table.

Hours from Noon.	Hours dist. on the Plane
	0 /
11	9 43
10	19 00
9	25 57
8	35 10
7	45 56
6	60 15
5	79 43

There is this Difference between *direct* and *declining Dials*, that the Hour-distances for the Afternoon on *declining Dials*, are not the same with the Hour-distances for the Forenoon, because the Sun remains longer on that Side of the Plane, which it declines to, than it doth on the contrary Side; therefore, there will be a greater Number of Hour-Lines upon it, and by Consequence the Distances of the Hour-Lines less than on the contrary Side of the Plane; therefore, for finding the Afternoon Hour-Distances, turn about the Quadrant of Altitude upon the Zenith Point, till the lower End of it

Q 2

comes

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comes to the Degree of the Horizon, opposite to that Degree of Declination, the Quadrant of Altitude was placed at, when the Distance of the Forenoon Hour-Lines was found, viz. to 63 Degrees, counted from the South towards the West, and bring the Vernal Colure again to the Meridian, and the Index to 12; then turning the Globe Westwards, as the Index points to the several Hours, or at each 15 Degrees of the Equator passing the Meridian, the Colure will cut the Quadrant of Altitude in the Afternoon Hour-Distances, numbered from the Zenith, as are expressed in the following Table.

Hours from Noon.	Hours dist. on the Plane
1	11 20
2	26 47
3	49 20
4	75 52

It is to be observed, that this Plane is capable of receiving no more Hour-Lines, after Noon, than 4, for when the Colure goes off the Quadrant of Altitude, the Sun goes off these Kind of Planes.

And to find the Distance of the *Subsilar-Line* from the 12 a-Clock-Line, and the Elevation of the Style about the Plane, which are two Requisites always to be found in upright declining Planes, bring the Colure to the Number of Degrees of the Plane's Declination, counted in the *Horizon*, from the South Point towards the East, and the Quadrant of Altitude to the Degrees of the Plane's Declination.

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Declination on the *Horizon*, from the North towards the East, so shall the Quadrant of Altitude, and the Colure, cut each other at Right Angles, and the Number of Degrees comprehended between the Colure and Zenith, in the Quadrant of Altitude, shall be the Number of Degrees between the Substilar-Line and the 12 a-Clock-Line, which, in this Example, is 19 deg. 45 min. and the Number of Degrees comprehended between the Quadrant of Altitude and the Pole, counted on the Colure, shall be the Number of Degrees that the Style is to be *elevated* above the Plane, which, in this Example, is 33 deg. 40 min.

The GEOMETRICAL CONSTRUCTION,
as in Plate II. Fig. 4.

Draw on your *Plane* an *Horizontal Line*, as CD, and with the Chord of 60 Degrees describe a Semicircle DBC, which divide into two equal Parts, and draw the Line AB, which will be the Hour of 12, then, from a Line of Chords, take the several Hour-distances from the Meridian, and lay on the Semicircle from B to C and D, drawing Lines from the Center A, through those Divisions, so shall all the Hour-Lines be represented on the Plane; then to represent the *Substilar-Line* on that Plane, from the Line of Chords, take 19 Degrees 45 Minutes, the Distance of the *Substilar-Line* from the 12 a-Clock-Line, and on the Semicircle

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micircle from the 12 a-Clock-Line at B, set it off to x, on the contrary Side to the Declination of the Plane, which, in this Case, must be in the West Side, and from the Center A draw A x, which shall represent the *Substilar-Line*; and from the *Substilar-Line*, lay off 33 deg. 40 min. the Elevation of the Style above the Plane, on the Circle from x to y, then draw the Line A y for the Style, or *Gnomon*, and let fall the Perpendicular a b upon the *Substilar-Line*, so you have a *Triangle*, which erected perpendicular upon the *Substilar-Line* A x, the Style A y shall be parallel to the *Axis* of the World, and cast a Shadow upon the Hour of the Day.

Here you may observe, that in *declining Dials*, the Style doth not stand at the same Elevation above the Plane, that it doth in *erect direct Dials*, neither doth it stand over the 12 a-Clock-Line, but on some Part of that Quarter towards which the Declination of the Plane is.

Thus you have finish'd your Dial, and in so doing, you have, in this one, made four Dials, *viz.*

A	{	North declining East	}	Deg. Min.
		North declining West		
		South declining East		
		South declining West		
				63 00

Only placing the Number of the Hours, and the Style respectively upon each Plane:

For

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For in the *South-West* Plane, the Style stands upon the Hour-Line of 2 in the Afternoon; in the *South-East*, declining as much, it will stand upon the Hour-Line of 10 before Noon. And so all the Morning Hours of the *West-Decliner*, will be the Afternoon Hours of the *East-Decliner*, and the Afternoon-Hours of the *West-Decliner* will be the Morning Hours of the *East-Decliner*; and the *South-East-Decliner* will produce the *North-West-Decliner*, and the *South-West-Decliner*, the *North-East-Decliner*, by only extending the Hour-Lines, Style and Substile, quite thro' the Center.

P R O B. IV.

Of Direct South Reclining DIALS.

Reclining Planes are those that cut the *Horizon* at Oblique Angles, *reclining* from the *Zenith*, or *inclining* to the *Horizon*, and are either *direct North, South, East, or West reclining*, or *declining* from the *North, West, &c.* and so are call'd *declining inclining Planes*.

A South Plane may so recline, that the Reclination thereof may be either

Less than
Equal to
More than } the Complement of the *Latitude*.

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Now, to reduce any of these Planes to a new *Latitude*, where they may become *Horizontal Planes*;

1. If the *Reclination* of the Plane be less than the Complement of the known *Latitude*, subtract the Plane's *Reclination* from the Complement of the *Latitude*, and the Remainder shall be a new *Latitude*, where the *Reclining Plane* shall be an *Horizontal Plane*; and, in this Case, the *South Pole*, in *North Latitude*, is always elevated.

2. If the *Reclination* be equal to the Complement of the *Latitude*: In that Case the *Plane* lies in the *Axis* of the *World*, and hath the *North Pole* elevated above it.

3. If the *Reclination* of the Plane be more than the Complement of the *Latitude*, subtract the Complement of the *Latitude* from the Plane's *Reclination*, and the Remainder shall be the new *Latitude*; and in this Case the *North Pole*, in *North Latitudes*, is always elevated.

In the first of these three *Varieties*: If a *South Plane* in the *Latitude* of 51 deg. 30 min. recline 20 Degrees, which is less than the Complement of the given *Latitude*; therefore the *Reclination* being subtracted from it, leaves 18 deg. 30 min. for the new *Latitude*: Wherefore, if you rectify the Globe to 18 deg.

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deg. 30 min. of Latitude, and find the Distances of the Hour-Lines from the *Meridian*, for a *Horizontal Dial* in that Latitude by *Prob. 1.* that Dial shall serve for a South Reclining 20 deg. in the Latitude of 51 deg. 30 min. and the *Height* of the *Stile* above the 12 Hour-Line, or Substile, will be equal to the new Latitude, namely 18 Degrees 30 Minutes.

In the *second Case*, when the *South Reclination* and Complement of the *North Latitude* are equal, the *Dial* is to be made in all respects like an *East* or *West Dial*; only that which in the *East* or *West Dial* is the Six o' Clock Hour-Line, must in these *Dials* be the Hour-Line of 12, &c.

In the *third Case*, suppose a South Plane to recline from the *Zenith* 60 deg. in the *Latitude* of 51 deg. 30 min. the Complement of which subtracted from 60 deg. leaves 21 deg. 30 min. for the new *Latitude*, and by *Prob. 1.* find the Hour-distances for the *Horizontal Dial* in that *Latitude*, which Hour-distances will serve for a South-Dial reclining from the *Zenith* 60 Degrees in the *Latitude* of 51 deg. 30 min. and the *Stile* of the Dial must be elevated above the Substile, or Hour-line of 12, 21 deg. 30 min. equal to the Complement of the *Latitude*, and point upwards towards the *North Pole*, as the *Stiles* of all South-Planes do, which recline more than the Complement of the *Latitude*; thus the Hour-distance of all *South* reclining

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reclining *Dials*, may be found by the *Globe*, by referring such reclining *Planes* to a *Latitude*, where they may become *Horizontal Planes*.

P R O B. V.

Of North reclining *DIALS*.

There are three *Varieties* of North *Decliners*, as there are of South *Recliners*, for the Reclination may be either

Less than	} the <i>Latitude</i> of the <i>Place</i> .
Equal to	
More than	

And to refer these to a new *Latitude*, where they will be *Horizontal Planes*, you must observe,

1. If the Reclination of the *Plane* be less than the *Latitude*, add the Complement of the *Latitude* to the *Plane's* Reclination, and the Sum will be the new *Latitude*. Thus, let a North *Plane* in the *Latitude* of 51 deg. 30 min. recline from the *Zenith* 20 deg. add 20 Degrees, the *Plane's* Reclension, to 38 deg. 30 min. the Complement of the *Latitude*, the Sum will be 58 deg. 30 min. which is the new *Latitude*. Wherefore, if you rectify the *Globe* to 58 deg. 30 min. and by *Prob. 1.* find the *Hour-distances* of a *Horizontal*

zontal Dial in that Latitude, those Distances will serve for a North Plane reclining 20 deg. in the Latitude of 51 deg. 30. min. North, and the *Stile* must be elevated above the *Substyle*, or *Hour-line* of 12, 20 deg. equal to the new Latitude.

In the second of these *Varieties*, where the Plane of the Meridian reclines, so as to cut the Meridian, just at the Intersection of the *Meridian* with the *Equator*, the Plane itself lying in the *Equinoctial Circle*, and the *Poles* thereof in the *Poles* of the World; it is call'd a *Polar Plane*. Wherefore rectify the Globe to 90 deg. of Latitude, so shall the *Poles* be in the *Zenith* and *Nadir*, and the *Equator* in the *Horizon*, then turn the Globe about till 15 Degrees of the *Equinoctial Colure* have passed the *Meridian*, and it will rest at 15 deg. of the *Horizon*, which is the first Hour's Distance from 12, and in these Planes the Degrees of the *Equator* and *Horizon* being the same, the *Hour-lines* are equally removed from one another; wherefore, if a Circle be described and divided into 24 equal Parts, *Lines* being drawn from the Center to each Division, and a *Wire* perpendicularly placed in the *Center*, the Dial is finished.

In the third Case, when the *Plane* reclines more than the Latitude, and cuts the *Meridian* between the *Equator* and the *Horizon*; add the *Reclination* to the Complement of the Latitude,

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Latitude, which Sum (if it don't exceed 90 deg.) is a new Latitude, but if it exceeds 90 deg. subtract that Sum from 180 deg. and the Remainder will be a new Latitude; for which new Latitude rectify the Globe, and make an *Horizontal Dial*, by *Prob. 1.* elevate the *Stile* above the 12 a-Clock Hour-line equal to the new Latitude, and the *Dial* is finished.

P R O B. VI.

Of Declining, Reclining, or Inclining P L A N E S.

Such *Planes* as do not behold the *East*, *West*, *North*, or *South* Points of the *Horizon* directly, are called *Decliners*, and if they are not perpendicular to the *Horizon*, they both decline and incline, therefore they are called *Declining Inclining Planes*; for the making of these kind of *Dials*, let us suppose a *Plane* in the *Latitude* of 51 deg. 30 min. to decline from the *North Part* of the *Meridian* towards the *West* 72 Degrees, and also to recline from the *Zenith* 26 deg. 34 min.

1. Elevate your *Globe* to the given Latitude 51 Deg. 30 Min. fix the Quadrant of *Altitude* in the *Zenith*, the *Hour-Index* to 12, and the *Equinoctial Colure* to the *Meridian*.

2. The

2. The *Declination* of the *Plane* being 72 deg. *Westward*, count upon the *Horizon* 20 deg. the Complement of the *Declination*, from the *South* Part of the *Meridian Westward*, and from the *North* Part of the *Meridian Eastward*, and to these two Points on the *Horizon* bring the Ends of a narrow Plate of thin Brass, containing a compleat *Semicircle*, divided into Degrees, beginning the *Divisions* at the Middle, and numbering them both Ways, and there fix it; then bring the *Quadrant* of *Altitude* to 20 Degrees on the *Horizon*, counted from the *East Southward*. Now because the *Plane* reclines 26 deg. 34 min. count those Degrees downwards from the *Zenith*, and to that Point bring the thin Plate of Brass representing your *Plane*, and there fix it; so is your *Globe* prepared for the making of your *Dial*; and for the Hour-distances, turn the *Globe Eastward*, till 15 Degrees of the *Equator* have pass'd the *Meridian*, and upon the *Plane*, or *Plate* of Brass, you will find the *Colure* cut the *Semicircle*, counted from the Middle of it at 26 deg. 3 min. and by turning still *Eastward*, and observing where the *Colure* cuts the *Semicircle* at each 15 Degrees of the *Equator*, passing the *Meridian*, you will find the Forenoon Hour-distances, as in the following Table; and the *Colure* being again brought to the *Meridian*, and the *Globe* turned to the *West*, at each 15 Degrees of the *Equator*, crossing the *Meridian*,
the

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the *Colure* will cut the *Semicircle* in the *Afternoon Hour-distances*, as in the following *Table*.

		Hours.	°	'
Forenoon	{	12	00	00
		11	26	3
		10	44	30
		9	57	47
		8	67	53
		7	76	12
		Substile	Substile	
Afternoon	{	6	84	15
		5	87	38
		4	78	25
		3	66	48
		10	50	46
		11	28	4

Now besides these *Hour-distances*, you must find four Things more, preparatory to the *Geometrical Construction* of these *Dials*.

1. *The Arch of the Plane, or the Distance between the Meridian and Horizon*, which may be found thus :

Take, with your *Compasses*, the *Distance* upon the *Plane*, from the *Intersection* of the *Plane* with the *Horizon*, to the *Intersection* of the *Plane* with the *Meridian*, which Number of

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of Degrees, namely, 36, is the Distance required.

2. *The Arch of the Meridian between the Plain and Zenith thus:* The Degrees of the *Meridian* intercepted between the *Plain* and *Zenith*, viz. 58 deg. is the *Arch* required.

3. *The Height of the Pole and Stile above the Plane.*

To find which, continue your *Quadrant* of *Altitude* from the *Zenith*, below the *Horizon*, so much as is the *Reclination* of the *Plane*, 26 deg. 34 min. and mark that Point. Then a thin *Plate* of *Brass* (if the *Quadrant* of *Altitude* be too short) divided, and extended from the *North Pole* towards the *South Pole*, and passing through the *Pole* of the *Plane*, which is the Point before found, mark where the *Plate* cutteth the *Plane*, and the *Number* of *Degrees* upon the *Plate* contain'd between the *Pole* and the *Plane*, which in this *Case* will be 31 deg. 28 min. is the *Height* of the *Pole* above the *Plane* or *Substile*.

4. *The Distance of the Substile from the Meridian.*

And that is, the *Number* of *Degrees* of the *Plate* representing the *Plane*, which are contained between the *Plate*, which came from the *Pole* of the *World* to the *Pole* of the *Plane*,

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Plane, and the *Intersection* of the *Plane* with the *Meridian*, which in this *Example* will be 82 deg. 4 min. as appears by the following Table.

	°	'
North Declining - - - - -	72	00
Reclining - - - - -	26	34
Distance between the Meridian and Horizon - - - - -	}	36 00
Distance between the Plane and Zenith - - - - -	}	58 36
Height of the Pole above the Plane - - - - -	}	31 28
Distance of the Substile and Meridian - - - - -	}	82 4

The Geometrical Construction of this DIAL.
Fig. 5. Plate 11.

1. Upon the *Plane*, upon which you intend to describe your *Dial*, draw a *Horizontal Line* thereupon, as A B, and another *Perpendicular* to it, as D G, for the *Vertical Line* of your *Plane*, cutting the former A B in the Point C, which Point C makes the *Center* of your *Dial*.

2. Upon

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2. Upon the *Center* C, with 60 deg. of a *Line of Chords*, describe a *Circle*, as AFBG, then take 36 deg. (*the Distance of the Meridian from the Horizon*) and set it from A to 12 downwards, and from B to 12 upwards, and draw the *Line* 12 C 12, for the *Hour-Line* of 12.

3. Take 82 deg. 4 min. (*the Distance of the Substile from the Meridian*) and set them from 12 upwards to G on the Left Hand, and downwards from 12 to G on the Right Hand, drawing the *Line* G C G, through the *Center*, for the *Subsilar Line* of both *Dials*: And the *Height of the Pole or Stile* above the *Plane* being 31 deg. 28 min. set those *Degrees* from G to H, both above and below, and draw the *Line* H C H quite thro' the *Center* for the *Axis* or *Stiles* of both *Dials*.

4. Laying your *Table* of *Hour-Distances* before you, and there finding the first *Hour's* Distance from 12 is 26 deg. 3 min. Set that Distance upon the *Circle* from 12 upwards to 1, and from 12 (on the other Side) downwards to 11, and draw the *Lines* G 1, and C 11; for the *Hour-Lines* of 11 and 1 a *Clock*, which will both make one strait *Line*.

Do thus with all the *Hours* in the *Table*, till you come upon the *Substile*, and then (beginning at the Bottom of the *Table*)

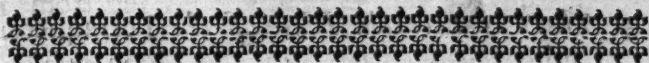
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5. Take

5. Take 28 deg. 4 min. and set from 12 on the Right Hand downwards to 11, and from 12 on the Left Hand upwards to One, draw the Line C 11 in the *North* reclining *Plane*, for the Sun will never shine upon the *South* reclining *Plane* at One, otherways you should have drawn it thro' the *Center* as you did before.

Lastly, Erect your *Stile* perpendicular to your *Substile*, making an *Angle* therewith equal to the *Elevation* thereof; namely, 31 deg. 28 min. and your *Dials* are finished. And in making of these you have made two others also, *viz.* A *North Declining* 72 deg. *Eastward*, and *Inclining* 26 deg. 34 min. and a *South Declining Westward* 72 deg. and *Inclining* as the other; all which is done, and may easily be apprehended by any Person, as is discovered in the 4th *Problem* of this *Section*, for *Upright Declining Planes*.





SECT. XVIII.

PARADOXES to be resolved by the
GLOBES.

1. **T**HERE is on the Terraqueous Globe a certain Parallel of Latitude, to which a Ship may be supposed to sail, and to have Sea-room, to depart from that Parallel; but such is the Situation of every Point of that Parallel of Latitude, that no Ship can sail from the said Latitude, but upon one particular Point of the Compass; and the Wind, tho' it veer round all the 32 Points, will always blow against that Point upon which the Ship must sail from that Latitude, and the Wind tho' blowing against the Point upon which the Ship must sail, yet the Ship may go directly before the Wind.
2. There are two Places on the Terraqueous Globe so situated, with respect to one another, that from each of those Places a Ship may sail, and tho' they have Sea-room to all the 32 Points, yet it is impossible for them to sail from those Places but upon opposite Points of the Compass; and tho' they sail upon opposite Points, yet they may, upon those Points, be either following or meeting one another.
3. There

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3. *There is a certain Place of the Terraqueous Globe to which the Sun and Moon rise always in the South, and set in the South.*
4. *There are two Places of the Earth which bear directly North and South of one another, and their Distance from each other is 100 Miles, but the true Course from one of those Places to the other is to sail 50 Miles due North, and 50 Miles due South.*
5. *There is a certain Place on the Terraqueous Globe to which a Ship may sail directly upon one Point of the Compass; but there are other Fourteen Points on which a Ship may sail towards that Place, but if she continue to sail upon e'er a one of the Fourteen, she will always approach nearer to the aforesaid Place, but will never be able to come to it.*
6. *There is a certain Parallel of Latitude upon which a Ship may sail round the Globe, and may all that Time observe the Body of the Sun, without his being above the Horizon.*
7. *There is a certain Place of the Earth from which two Ships may depart on one and the same Day, yea, and on the same Hour and Minute of that Day, and upon one and the same Point of the Compass, may continue to sail with the same Velocity for the Space of*

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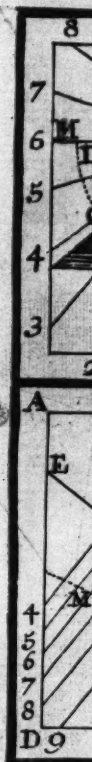
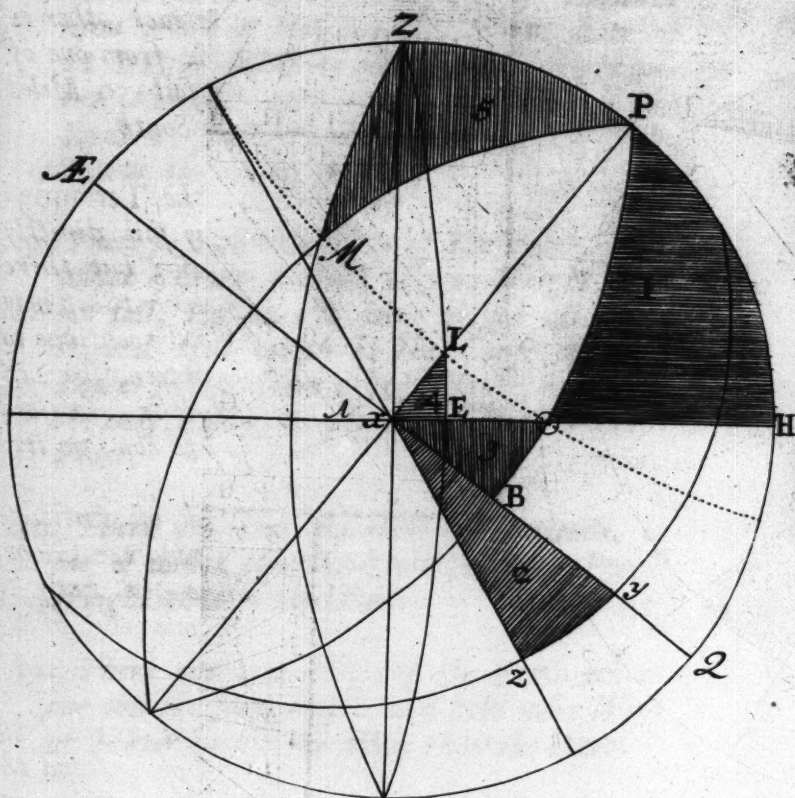
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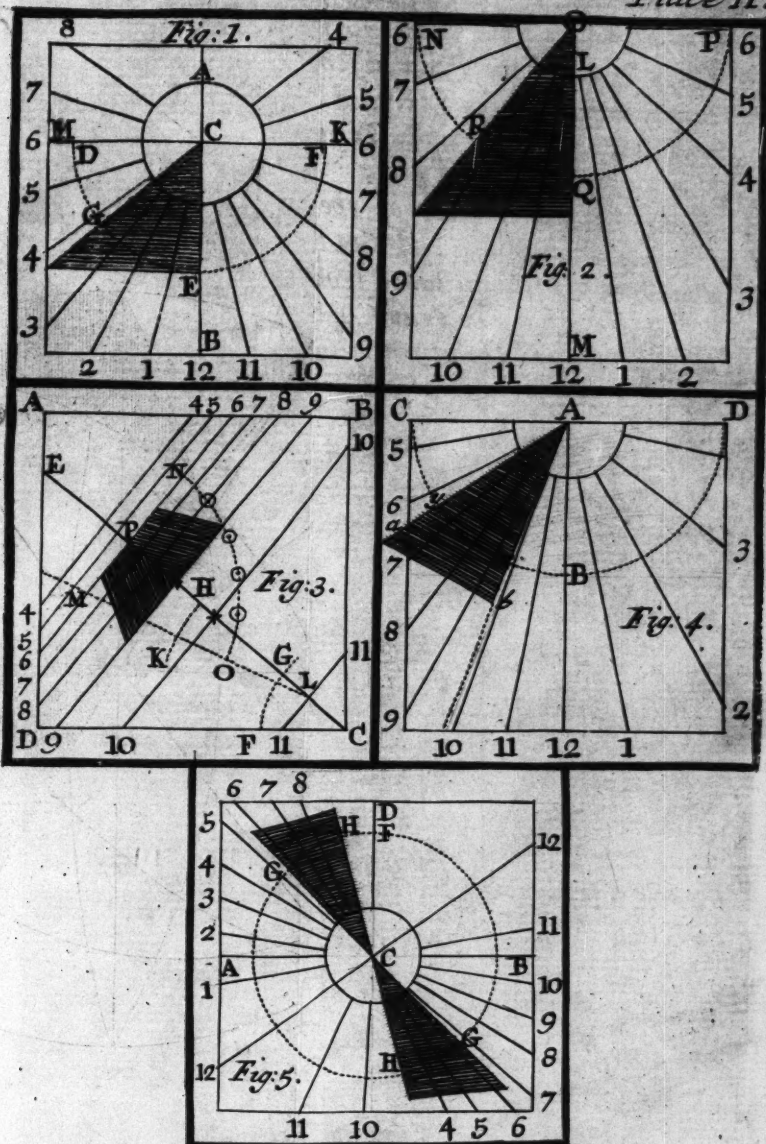
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24 Hours, and tho' they depart from the same Place, and at the same Time, and both sail upon the same Point of the Compass, with the same Velocity, yet, in 24 Hours, they will be distant from one another above 1000 Italian Miles.

8. *There is a certain Parallel of Latitude upon which a Ship may sail at the Rate of 12 Italian Miles an Hour, and in 24 Hours her Velocity, measured in Degrees of the Equator, shall be equal to the Velocity of the Sun on the 10th of June.*
9. *There is a certain Place of the Earth, from which a Stone of about 10,000 Weight could not fall, tho' a Pit were digged all round it, and that which is the Cause of other Bodies falling from other Places, would be the only Pillar to support a Body in that Place.*
10. *There are two Parallels of Latitude, in one of which less Gold will make a Pound Weight than in the other.*
11. *There are two Places of the Earth where one and the same Vessel will hold more Wine or Water in the one Place than the other.*
12. *There is a certain Parallel of Latitude from which two Ships may sail at one and the same Moment of Time, with respect of real*
R 3 *Time,*

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Time, and with respect of apparent Time, will differ one intire natural Day; but there is another Parallel of Latitude, to which, if those two Ships sail upon one and the same Point of the Compass, with the same Velocity, they shall arrive at that certain Parallel of Latitude at one and the same Moment, both with respect to real and apparent Time.

13. *There is a certain Place of the Earth where all the fixed Stars have still the same Altitude; and notwithstanding of the Diurnal Revolution of the Earth, they always bear upon the same Point of the Compass.*
14. *There are several Places at a considerable Distance from one another, that lie all directly East of London, but London does not lie directly West from any of the said Places.*
15. *The Christians observe the first Day of the Week for their Sunday, the Jews the seventh for their Sabbath, and the Turks the sixth Day of the Week for the Time of their Worship; but there is a particular Place of the Globe to which, if a Christian, Jew, and Turk sail in one and the same Ship, they shall keep the Time for their Worship on different Days, as above, all the Time they are sailing to that particular Place; but when they arrive at that Place,*
and

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and during the Time they remain at it, they shall all keep their Sabbath on one and the same Day; but when they depart from that Place, they shall all differ as before.

16. *There is a certain Port, from which, if three Ships depart at one and the same Time, and sail on three particular different Courses till they return to the Port they departed from, and if in one of these Ships be Christians, in the second Jews, and in the third Turks, when they return to the Port they departed from, they shall differ so with respect to real and apparent Time, that they all shall keep their Sabbath on one and the same Day of the Week, and yet each of them, separately, shall believe that he keeps his Sabbath on the Day of the Week his Religion requires.*

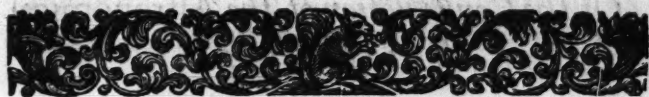
17. *There is a certain Country in the North Temperate Zone, to whose Inhabitants the Bodies of the three Superior Planets, Saturn, Jupiter, and Mars appear to be most enlighten'd, when they are actually least enlighten'd.*

18. *There is a Continent all lying in the North Side of the Equator, to whose Inhabitants the Body of the Sun seems to be nearest to them, when he is the farthest removed from them.*

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19. *There is a certain Parallel of Latitude, on which Parallel the Star, called the North Polar Star, appears, by Observation, to be 47 Degrees elevated above the Horizon, and at another Time the said Polar Star will appear, by an Observer on the same Parallel of Latitude, to be at the Horizon.*
20. *There are two Places lying in the Torrid Zone that are not above 60 Miles distant from one another, but if a Ship sail from one to the other, on one particular Point of the Compass, the Difference of Time between those two Places will actually be found to be above 23 Hours.*
21. *There are 24 Places on the Terraqueous Globe in which all the 24 Hours of the natural Day do always exist at the same Time, and yet the Distance of any two of those Places does not exceed 60 Miles.*





S E C T. XIX.

*Containing a Description, and the Uses
of TELESCOPES.*

A Telescope is an Optick Instrument which serves to discover Objects at a Distance; the Invention of which is one of the noblest and most useful these Ages have to boast of: By Means hereof the Wonders of the Heavens are discover'd to us, and Astronomy brought to a Degree of Perfection, which former Ages could have no Idea of. The Optick Principles, whereon Telescopes are founded, are contain'd in *Euclid*, and it is for want of Attention thereto, that the World was so long without that admirable Invention; as no doubt there are a great many others lying hid in the same Principles, only waiting for Reflection or Accident to bring them forth.

Telescopes are either *Refracting* or *Reflecting*. *Refracting Telescopes* are of several Kinds, and are distinguished by the Number and Form of their Lens's or Glasses, and denominated from their particular Uses, &c. Such are the Terrestrial or Land Telescope, and the Cœlestial or Astronomical Telescope.

I. *Of*

I. *Of the Construction of the Astronomical*
TELESCOPES.

IF a Telescope consists only of a Convex Object Lens, and an Eye-Glass of a much greater Convexity than the Object-Glass is, then will the apparent Magnitude of the Object seen through that Telescope, be to the Object seen by the naked Eye at the Station of the Object-Glass, as the Focal Length of the Object-Glass to the Focal Length of the Eye-Glass. Thus in Plate 12. Fig. 6. let A B represent the Object-Glass, and suppose its Focal Length H d 12 Foot or 144 Inches, and the Eye-Glass represented by c D, its Focal Length 3 Inches; then the apparent Diameter of the Object, seen through such a Telescope to that seen through the naked Eye, will be as 144 to 3, or as 48 to 1, wherefore such a Telescope will be said to magnify 48 times, and its Surface 2304 times (*i. e.* the Square of 48).

Wherefore if the same Object-Glass be combined with an Eye-Glass whose focal Distance is 1, and at another time with an Eye-Glass whose focal Distance is 2, the former Telescope will magnify twice as much as the latter. Also, if two Telescopes have different Lengths, and the Focus of the Eye-Glass of the shorter be in the same Proportion to

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to the Focus of its Object-Glass, as the Focus of the Eye-Glass of the longer bears to its Object-Glass, then those two Telescopes will *magnify alike*. But yet long Telescopes are of very great use, and it is impossible to make short ones perform as well: For,

1. Object-Glasses of a shorter Focus, will not bear Eye-Glasses proportionably short without colouring the Object, or rendring it dark and obscure.

For Instance: Suppose a very good 12 Foot Object-Glass will receive an Eye-Glass of no shorter Focus than 3 Inches, with *Clearness* and *Distinctness*, yet, however, an Object-Glass of 24 Foot Focus, equally good, will bear an Eye-Glass of less than 6 Inches Focus, (perhaps of 4 or 5 Inches Focus) with equal *Clearness* and *Distinctness*; and then, tho' an Object-Glass of 12 Foot, with an Eye-Glass of 3 Inches, will magnify but 48 times, as is above proved, yet an Object-Glass of 24 Foot, with an Eye-Glass of 4 Inches, will magnify 72 times, which is above one Third more than the former.

2. The Image of the Moon, or any other Object, in the distinct Base of an Object-Glass of 24 Foot, is twice as long as the Image of the distinct Base of an Object-Glass of 12 Foot; and consequently the Image in the former will be much more plain and distinct. Hence may be concluded also, that if the
Object-

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Object Glafs be formed on a lefs Sphere than an Eye-Glaf, the Appearance of Objects will be diminished in the aforefaid Proportion ; as is plain by the Cafe, when a Telescope is inverted. But for a more particular Con-
 ftruction of the fame Telescope, let A B as before (Plate 12. Fig. 6.) represent the Convex Glafs next the Object C D, the other Glafs more Convex near the Eye. Suppose the Object-Glaf A B to form the Image of the Object at E F, fo that if a Sheet of White Paper were to be held in this Place, the Object would appear. Now fuppofe the Rays, which pafs the Glafs A B, and are united about E F, to proceed to the Eye-Glaf C D, and be there refracted : Three only of thefe Rays are drawn in the Figure ; thofe which pafs by the Extremities of the Glafs A B, and that which paffes its Middle. If the Glafs C D be placed at fuch a Dif-
 tance from the Image E F, that the Rays, which pafs by the Point F, after having proceeded through the Glafs diverge fo much, as the Rays do that come from the Object, which is at fuch a Dif-
 tance from the Eye as to be feen diftinctly ; thefe being received by the Eye, will make on the Bottom of the Eye a diftinct Representation of the Point F. In like manner the Rays, which pafs through the Object-Glaf A B to the Point E, after proceeding through the Eye-Glaf C D, will, on the Bottom of the Eye, make a diftinct Representation of the Point E ; but if the
 Eye

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Eye be placed where these Rays, which proceed from E, cross those which proceed from F, the Eye will receive the distinct Impression of both these Points at the same time, and consequently will also receive a distinct Impression from all the intermediate Parts of the Image E F; that is, the Eye will see the Object, to which the Telescope is directed, distinctly. The Place of the Eye is about the Point G, where the Rays H E, H F cross, which pass through the Middle of the Object-Glass A B to the Points E and F, or at the Place where the Focus would be formed by Rays coming from the Point H, and refracted by the Glass C D. To judge how much the Instrument magnifies any Object, we must first observe, that the Angle under E H F, in which the Eye, at the Point H, would see the Image E F, is nearly the same as the Angle, under which the Object appears by direct Vision; but when the Eye is in G, and views the Object through the Telescope, it sees the same under a greater Angle; for, the Rays, which coming from E and F cross in G, make a greater Angle than the Rays which proceed from the Point H to these Points F and E. The Angle at G is greater than that at H in the Proportion as the Distance between the Glasses A B and C D is greater than the Distance of the Point G from the Glass.

This Telescope inverts the Object; for the Rays, which come from the Right Hand
Side

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Side of the Object, go to the Point E the Left Side of the Image; and the Rays, which come from the Left Side of the Object, go to F the Right Side of the Image. These Rays cross again in G, so that the Rays, which come from the Right Side of the Object, go to the Right Side of the Eye; and the Rays from the Left Side of the Object go to the Left Side of the Eye; therefore, in this Telescope, the Image in the Eye has the same Situation as the Object; and seeing that in direct Vision the Image in the Eye has an inverted Situation, here, where the Situation is not inverted, the Object must appear so. This is no Inconvenience to Astronomers in Cœlestial Observations, but for Objects here on the Earth it is usual to add two other Convex-Glasses, which may turn the Object again, as is represented in Plate 12. Fig. 7. or else to use the other kind of Telescope, with a concave Eye-Glass.

II. *Of the Construction of a Land or Day* TELESCOPE.

A Land or Day Telescope consists of more than two Lens's, commonly of a Convex Object Glass, and three Convex Eye-Glasses, by which it exhibits Objects erect: The Construction of it thus.

Having provided a Tube, fit in an Object-Glass, which is either Convex on both Sides,

or

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or Plano-Convex, and a Segment of a large Sphere : To this add three Eye-Glasses, all Convex on both Sides, and Segments of equal Spheres, disposing them in such manner as that the Distance of any Two may be the Sum of the Distances of their Foci : Then will an Eye, applied to the least Lens, at the Distance of its Focus, see Objects very distinctly erect and magnified in the Ratio of the Distance of the Focus of one Eye-Glass, Plate 12. Fig. 7. to the Distance of the Focus of the Object-Glass.

For, 1. The Rays falling upon the Object-Glass parallel, the Image of the Object will be represented inverted at the Distance of the principal Focus ; wherefore, since this Image is in the Focus of the first Eye-Glass, the Rays, after a second Refraction, will become parallel, and thus falling on the third Lens, after a third Refraction, they exhibit the inverted Image invertedly, that is, a direct Image of the Object : Since then this Image is in the Focus of the third Eye-Glass, the Ray, after a fourth Refraction, will become Parallel, and in this Disposition the Eye will receive them, and consequently there will be distinct Vision, and the Object will appear erect.

2. When the Eye-Glass is concave, the Effect is founded on the same Principles, as in the former. The Distinctness of the Appearance is procured in the same Manner : But here the Eye-Glass CD (in Fig. 8.) is placed between the Image EF, and the Object Glass A B :

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By this means the Rays, which come from the Right Hand Side of the Object, and proceed toward E the Left Side of the Image, being intercepted by the Eye-Glass, are carried to the Left Side of the Eye; and the Rays, which come from the Left Side of the Object, go to the Right Side of the Eye; so that the Impression in the Eye being inverted, the Object appears in the same Situation, as when view'd by the naked Eye: The Eye must here be placed close to the Glass. The Degree of magnifying, in this Instrument, is thus to be found: Let the Rays, which pass through the Glass AB at H, after the Refraction of the Eye-Glass CD diverge, as if they came from the Point G; then the Rays, which come from the Extremities of the Object, enter the Eye under the Angle at G, so that here also the Object will be magnified in the Proportion of the Distance between the Glasses, to the Distance of G from the Eye-Glass.

The Space, that can be taken in at one View in the Telescope, depends on the Breadth of the Pupil of the Eye; for as the Rays, which go from the Points E F of the Image, are something distant from each other, when they come out of the Glass C D, if they are wider asunder than the Pupil, it is evident that they cannot both enter the Eye at once. In the other Telescope the Eye is placed in the Point G, where the Rays that come from the Points E or F cross each other, and therefore

fore must enter the Eye together. On this Account the Telescope, with Convex Glasses, takes in a larger View than those with Concave; but in these also the Extent of the View is limited, because the Eye-Glass does not, by the Refraction towards its Edges, form so distinct a Representation of the Object, as near the Middle.

Hence an Astronomical Telescope is easily converted into a Land Telescope, by using three Eye-Glasses for one; and the Land Telescope, on the contrary, into an Astronomical one, by taking away two Eye-Glasses, the Faculty of magnifying remaining the same: Since the Distance of the Eye-Glass is very small, the Length of the Telescope is much the same, as if you only used one.

3. From the Construction it is evident that the Length of the Telescope is had, by adding five times the Semidiameter of the Eye-Glasses to the Diameters of the Object-Glass, if a Plane Convex, or its Semidiameter if a Convex on both Sides.

Heugens first observed, both in the Astronomical and Land Telescope, that it contributes considerably to the Perfection of the Instrument, to have a Ring of Wood or Metal, with an Aperture, a little less than the Breadth of the Eye-Glass, fixed on the Plane where the Image is found to radicate upon the Lens next the Eye; by means hereof the Colours which are apt to disturb the Clearness and Distinctness of the Object are prevented,

vented, and the whole Compass taken in at a View perfectly defined.

Sir *Isaac Newton*, in his admirable Treatise of Opticks, Page 59. demonstrates, That the Perfection of Telescopes is impeded by the different Refrangibility of the Rays of Light, and not, as hath been vulgarly supposed, by the spherical Figures of Glasses; and consequently they cannot be perfected by Glasses of the Figures of the Conick Section, *i. e.* by Parabolick Hyperbolick Glasses, &c. for having shewed the Ratio between the less and greater Refractions of the different Rays to be very nearly as 27 to 28. he saith, Those that are skill'd in Opticks will easily understand that the least circular Space, into which the Object-Glasses of Telescopes can collect all sorts of parallel Rays, is about the $27 \frac{1}{2}$ Part of half the Aperture of the Glass, or the 55th Part of the whole Aperture; and that the Focus of the most refrangible Rays is nearer to the Object-Glass than the Focus of the less refrangible ones, by about $27 \frac{1}{2}$ Part of the Distance between the Object-Glass, and the Focus of the mean refrangible ones.

And if Rays of all Sorts, flowing from any one lucid Point in the Axis of any Convex Lens, be made by the Refraction of the Lens to converge to Points not too remote from the Lens, the Focus of the most refrangible Rays shall be nearer to the Lens than the Focus of the least refrangible Rays, by a Distance which is to the $27 \frac{1}{2}$ Part of the

Distance

Distance of the Focus of the mean refrangible Rays from the Lens, as the Distance between that Focus and the lucid Point from whence the Rays flow, is to the Distance between the lucid Point and the Lens very nearly.

After this he shews, by Experiments made with very great Accuracy, that the Rays of Light, which differ in Refrangibility, do not all converge to the same Focus; but if they flow from a lucid Point, as from the Lens on the one Side, as their Foci are on the other, the Focus of the most refrangible Rays shall be nearer to the Lens than that of the least refrangible, by above the 14th Part of the whole Distance: And if they flow from a lucid Point so very remote from the Glass, that, before their Incidence, they may be accounted parallel, the Focus of the most refrangible Rays shall be nearer to the Lens than the Focus of the least refrangible, by a 27th or 28th Part of their whole Distance from it: And the Diameter of the Circle in the Middle Space between these two Foci, which they illuminate when they fall there on any Plane perpendicular to the Axis, (which Circle is the least into which they can be gather'd) is about the 55th Part of the Diameter of the Aperture of the Glass; so that 'tis a Wonder that Telescopes do represent Objects so distinctly. But were all the Rays of Light equally refrangible, the Error arising only from the Sphericity of the Figures of Glasses, would be many hundred times less.

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And by Calculation, *Page* 70. he proves, That the Error arising from the Spherical Figure of Glasses, to that arising from the different Refrangibility of the Rays, is as 1 to 8151, and consequently is so little, as deserves not to be consider'd.

There is another Argument (saith our excellent Author, *p.* 73.) which proves, that the different Refrangibility of the Rays is the true Cause of the Imperfection of Telescopes: For the Errors of the Rays, arising from the spherical Figures of the Object-Glasses, are as the Cubes of the Apertures of such Object-Glasses; and thence to make Telescopes, of various Lengths, magnify with equal Distinctness, the Apertures of the Object-Glasses, and the Charges, or magnifying Powers, ought to be as the Cubes of the Square Roots of their Lengths, which doth not answer to Experience: But the Errors of the Rays arising from the different Refrangibility, are as the Apertures of the Object-Glasses; and thence to make Telescopes of various Lengths magnify with equal Distinctness, their Apertures and Charges ought to be as the Square Root of their Lengths; and this answers to Experience, as is well known: For Instance; a Telescope of 64 Feet in Length, with an Aperture of $2\frac{2}{3}$ Inches, magnifies about 120 times with as much Distinctness as one of a Foot in Length, with $\frac{1}{2}$ of an Inch Aperture, magnifies 15 times.

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By Reason of this different Refrangibility, he concludes, That there can scarce be any other Means of improving Telescopes by Refractions alone, besides that of increasing their Lengths; for which End the late Contrivance of *Hugenius* seems well accommodated, (see *Philosophical Transactions*, N^o 161.) for in his Aerial Telescope, the Glasses are readily manageable, and the Object-Glass being upon a strong upright Pole, becomes more steady.

III. *Of the Construction of a Reflecting* TELESCOPE.

THE Reflecting or Catoptrick Telescope, is a Telescope which instead of Lens's consists chiefly of Mirrors, and exhibits remote Objects by Reflection, as the other Telescope before describ'd does by Refraction.

The great Sir *Isaac Newton*, considering the different Refrangibility, which in his new Doctrine of Light and Colours he has made appear the Light to consist of;

In Effect, as he found the Ratio between the greatest and least Refractions of the different Rays, to be nearly as 28 is to 27, it easily followed, that the Rays could never be all refracted parallel from any Lens, but would some of them divaricate, some more,

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some less, besides that the Foci would be disturbed; the Focus of the more refrangible Rays being nearer the Lens than those of the least refrangible Rays, by a Distance which is the 27th Part of the Distance between the Object-Glass and the Focus of the least refrangible ones.

Hence he concludes, that Refraction was too unequal a Principle, and that Lens's of whatever Figure, whether spherical, parabolical, or any other of the Conick Sections; and how truly soever ground, will never suffice for the Perfection of Telescopes.

Upon this he had recourse to another more equitable Principle, *viz.* Reflection, and made a Telescope, consisting of a Metalline Speculum, the first Hint whereof he owns he took from Dr. Gregory's Opticks.

The Construction of Sir *Isaac Newton's* reflecting Telescope is as follows. The Object-Metal A, Plate 12. Fig. 9. is placed in one End of the Octangular Tube B B at a a; the Tube is about Six Feet long, and a little wider than what is sufficient to receive the Metal, dyed Black on the Inside. The Radius of the Sphere, on which the Concave Metalline Speculum must be ground fit for a Tube of such a Length, will be about Ten Feet, and consequently its Focal Length will be about 62 Inches. The Metalline Speculum is solder'd on the Back to another of Brass, in the Back of which there is a Female Screw to receive a Handle, whenever the Metal is to be

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be moved, in order to avoid sullying its polish'd Surface by handling. As far within the Focus of the Concave Speculum as is the Semidiameter of the Tube, there is to be placed an Oval Plane, composed of a Plate of the same Metal with the great Speculum, solder'd on the Back to another of Brass. Its Breadth is something less than half an Inch, and is in Proportion to its Length as one is to the Square Root of two. This plain Speculum is to be disposed so, as to reflect the Rays to E, which Point will be the Focus of the Concave Speculum; and if a Sheet of Paper were held to the Point E, the Image of the Object would be painted on the Paper by Reflection. There are belonging to the Instrument three Boxes with Convex Eye-Glasses, to be screwed on at the Focus E, that by the Help of those Glasses, the Eye may receive the Rays parallel, which proceed from the Image of the Object at E. When the first or shallowest of the Eye-Glasses is made use of, it magnifies about 180 times in Diameter, with the Second about 200, and with the Third about 230 times: Each of those Glasses has placed in that Focus, nearest the Oval, a Circle to determine the Part of the Object seen at one View; and in the other Focus, towards the Eye, a Brass Plate, with a little Hole in the Middle, to let no Light pass from the Eye to the Inside of the Tube but what comes from the Oval. Besides these three Convex, there are two Con-

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cave Eye-Glasses, with which it magnifies about 200 and 220 times, and also a Sett of three Convex Eye-Glasses, which turn it into a Day Telescope, magnifying about 125 times. The Aperture is limited by a Circle of Card or Pastboard, placed before the Object-Metal in the Tube. To vary the Aperture there are three of those Circles, and the Apertures allowed by them are Five Inches and an Half, Five Inches, and Four and an Half, tho' for some Objects the whole Metal may be left open.

On the Top of the Tube is fix'd, on two small Pedestals, a common Dioptrick Telescope about 18 Inches long, its *Axis* parallel to that of the Tube, and having two Hairs placed in the common *Focus* of its Object, and Eye-Glasses crossing one another in its *Axis*. By this Dioptrick Telescope, the Object may be brought to be opposite to the Tube of the reflecting Telescope, much sooner than to the reflecting Telescope alone, and is represented in the Figure at M N.

The open Air has commonly an undulating Motion in its Parts, especially in the Day-time, which occasions the Rays of Light to deflect a little from the strait Lines in which they ought to move, in order to render the *Species* perfectly distinct: The Effect of this, though insensible to the naked Eye, or even through a small Telescope, becomes considerable when the Object is very much magnified.

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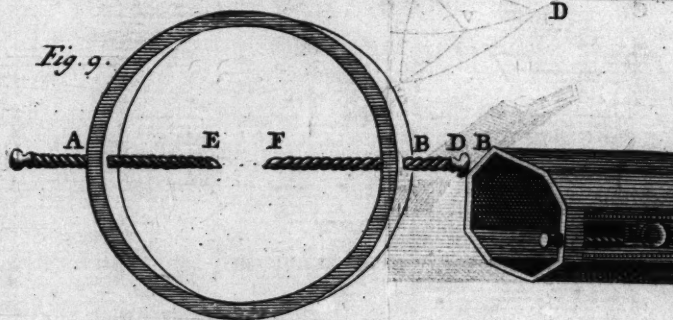
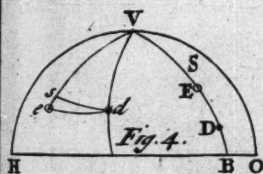
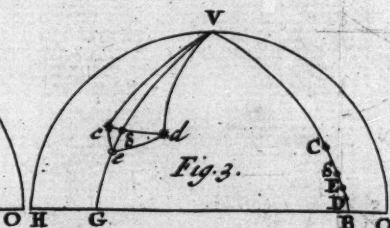
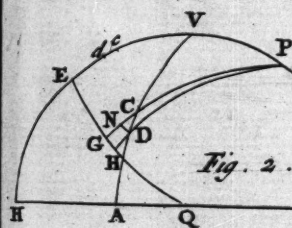
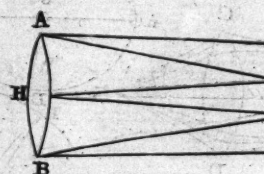
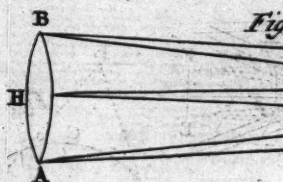
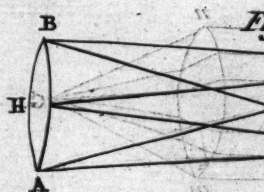
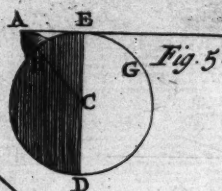
Dr. *Gregory's* Reflecting Telescope (who was certainly the first that gave the Construction of those Telescopes, tho' not the first that put them in Practice) is very much different from Sir *Isaac Newton's* Telescope: The Construction of Dr. *Gregory's* is thus; Let A B C D, Plate 12. Fig. 10. be a Tube, open at A D; in the End B C there is to be fitted a Concave Speculum m n, in which there must be a Hole x x agreeing to a Hole y y of the Tube A B C D; within the Focus of the Concave Speculum, as at G, there is to be placed a plain Convex Speculum as c e, which receiving the Image of the Object from the Concave Speculum, reflects the Rays back upon the Concave Speculum, diverging, a Quantity of those Rays, passes thro' the Hole x x, where they are received by the Tube M o c n, in which there are Eye-Glasses of the same Nature with common Refracting Telescopes, which Tube M o c n being screw'd to the Tube at y y, the Observer will receive a distinct Image of the Object, and erect: Thus tho' the Principles of Sir *Isaac's* and Dr. *Gregory's* Telescopes be the same, yet their Construction are different, Sir *Isaac's* Telescopes having the Eye-Glasses placed upon the Side of the Tube, as at e, and in Dr. *Gregory's* Telescopes they are placed in the End, as at y y, where they look directly as in Refracting Telescopes. Both Sorts of these Reflecting Telescopes are now made to very great Perfection, by Mr. *Edward Scarlet*, Optician

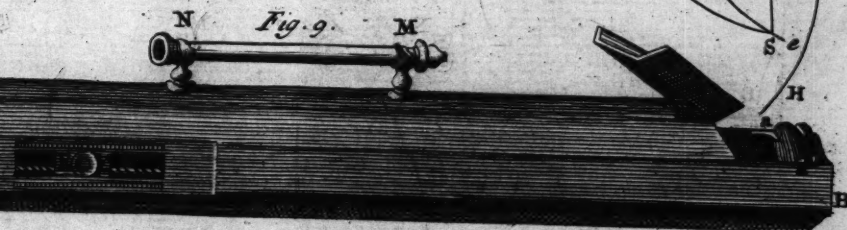
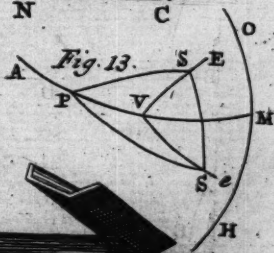
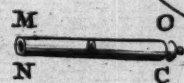
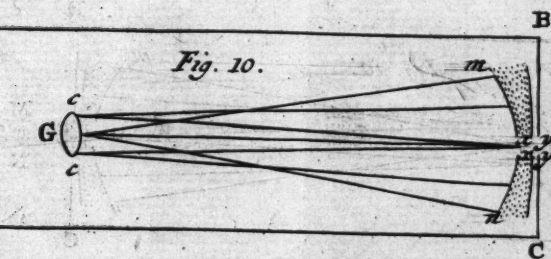
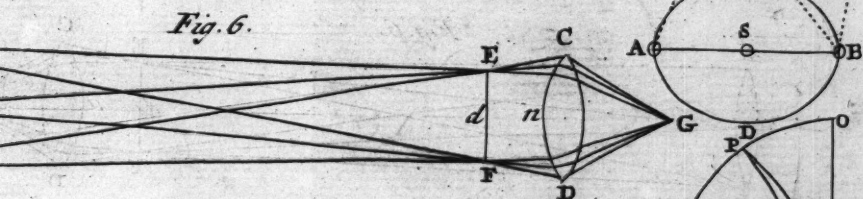
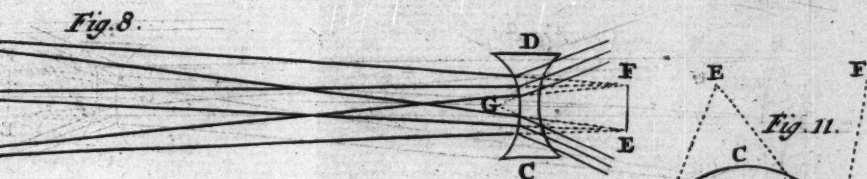
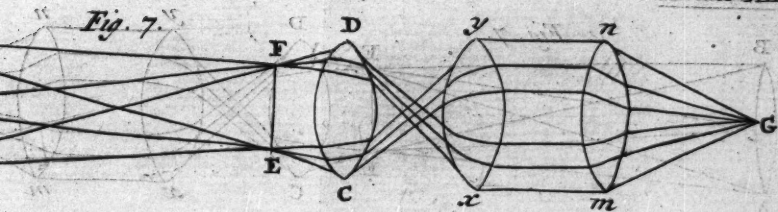
tician to his Majesty, by St. Ann's Church, Soho; he has lately made one of Dr. Gregory's Telescopes of about 9 Inches in Length, by which the Satellites of *Jupiter* are very distinctly observed: Also, there is a late Contrivance, by which the Azimuth and Altitude of any Coelestial Phenomenon, may be observed at the same Time that the Object is observed by those reflecting Telescopes: But this Contrivance, as also the Movements, which carry the Telescope either vertically or horizontally, are immediately understood when seen, as executed by the above-mention'd Mr. *Scarlet*.

Of the Uses of TELESCOPES.

BY the Help of Telescopes distant Objects are more certainly and exactly observed than they can be by our simple View; for by the Measure of Angles we find the apparent Diameters of distant Bodies, for the apparent Diameter of Bodies, grow bigger the nearer we come to them, and that they are increased almost in the same Proportion that the Eye approaches them; (for Example; If any Man were ten times nearer to the Moon than we are, and did there observe her, he would see the Moon ten times bigger in her Diameter, and clearer than we do; in Diameter, I say, for the Surface would appear 100 times larger than it does to us). If here

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on our Earth we should take a Telescope, which only encreases the Diameter ten times, and look to the Moon with it, the Moon will have the same Appearance seen with such a Telescope, as would appear to a Spectator ten times nearer the Moon than we are; but if we should use Telescopes (and such there are) which magnify the Diameters of Objects 100 or 200 times, they will shew the Moon in the same Manner, Figure, and Bigness, as it would appear in, at a Distance 100 or 200 times less than ours is from the Moon. Hence we can perceive, with our Eyes, what Face, and how large the Moon would shew it self at the Distance of three Diameters of the Earth: As likewise, we can discern how the Moon would appear if we approach'd much nearer, and view her only at the Distance of 1000 Miles, for from thence we should be able to discover, in the Moon, vast Ridges of Mountains, deep Caverns, many Vales, and large open Fields. By the Means of Telescopes we still ascend higher in the Heavens, and we can approach the Planets and Comets, and fixed Stars, so near, that of such immense Distances there remains only the Hundredth or Two Hundredth Part to have the whole Journey finished; for, as is before observ'd, a Telescope, that magnifies One Hundred Times, makes any Object appear to us, when view'd by such a Telescope, as if the Distance between the Observer and that Object were divided into One Hundredth equal

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equal Parts, and if the Observer were removed Thirty Nine of those Parts nearer to the Object, the Observer, with the naked Eye, would then see the Object in the same Bigness in Diameter and Surface, and other Appearances, as the same Observer on our Earth observes the same Object with a Telescope that magnifies One Hundred times; and as Telescopes are of vast use in observing the apparent Diameters of the Cœlestial Bodies, so likewise we thereby are able to judge of the Proportion of their Distances from us, and the Proportion their true Diameters bear to one another; for if their Distances be equal, their true Diameters will be as their apparent, and if their apparent Diameters are equal, their true Diameters will be proportional to their Distances: Hence, if the apparent Diameters of the Sun and Moon be equal, let the Sun be One Hundred times further from us than the Moon, the Sun must needs be One Hundred times in Diameter bigger than the Moon.

If we know the apparent Diameter of any Body, we can from thence exactly know by the help of Trigonometrical Tables what Proportion the Distance of that Body bears to its true Diameter; for suppose any Object to be seen by the Eye under an Angle of one Degree; the Distance of that Object will be to its Diameter, as the Radius of a Circle is to the Tangent of one Degree. The Sun appearing under an Angle of about half a Degree,

gree, or 30 Minutes; this Distance will be to his real Diameter as 10000 to 87, the Tangent of half a Degree. Hence we are certain; that the Sun's Distance from us is nearly equal to 115 of his own Diameters; and if an Eye were placed on the Sun to observe the Angle under which the Diameter of the Earth appear'd from thence, we then should be able to tell exactly the Distance of the Sun from us in Diameters of the Earth or Miles.

In order to determine the apparent Diameters of the Planets; as also to measure other small Distances in the Heavens accurately; there has been several sorts of Micrometers apply'd to the Focus's of Telescopes: the Construction of the most simple of those Micrometers is as follows: In the Focus of a Telescope fit a Brass or Iron Ring AB with Female Screws diametrically opposite to each other; into these Female Screws insert Male Screws AE and FB of such Lengths as that they may be turn'd into the Tube so as to meet each other, and with this Instrument very small Spaces in the Heavens may be accurately measured; for when any two Objects view'd thro' the Tube appear contiguous to the Screws, if the Telescope be turn'd about to two other Points that do also exactly appear contiguous to the Screws, they remaining in the same Position as before, if the Distance asunder of those two latter Points be known or can be measured, the same will be the Distance asunder of the first two Objects. To determine how many Seconds
answer

answer to each Thread of those Screws, observe two Points in the Heavens, whose Distance is accurately known, and turn the Screws till they appear contiguous with those known Objects; and observe the Number of Threads corresponding to that Interval; then by the Rule of Three it may easily be determin'd how much of that, or any other Interval agrees to every Thread of the Screw; thus, by saying, As the Number of the Threads of the Screws requir'd to measure the known Distance, is to the known Distance in Seconds; so is one Thread to a fourth Number, which fourth Number is the Number of Seconds answering to each Thread of every Screw. After the same manner may a Table be made, by which the apparent Distances of Objects, or the apparent Diameters of the Planets may be found by Inspection; having the Number of Threads of the Screws that measure that Interval.

N. B. The Screws should be as exactly made as possible.

Also by the Help of Telescopes, the Motion of the Sun round his Axis is discover'd; for upon the Account of the great Distance of the Sun from us, the Convexity of his Body cannot be perceiv'd by our Sight; nor is this a Wonder, since the Moon, which is much nearer to us, cannot be seen as a Globular Body; but both Sun and Moon appear to us, as if they were Circular Planets, which we call *Disks*. And a Point in the middle, which is really in the Surface, is said to be the Center, or the apparent

parent Center of the *Disk*. If the Sun, thro' all his Parts were every where equally bright, and shin'd with the same Lustre, he might turn round his own *Axis*, and that Rotation no ways be perceptible, not to be discover'd by our *Senses*: But since in the most clear and lucid Body of the Sun, and in its purest Flames, many black Spots have several times been observ'd; it is by their Motion that we discover the Rotation of the Sun round his *Axis*; for these Spots have been observ'd to have first appear'd near the Margin of the Sun, and then by degrees to have crept towards the Middle or Center of his *Disk*; and from thence going still forward, have arriv'd at the opposite Side or Edge of the *Disk*, where they have set or disappear'd; and some of them after Setting being hid or absconded in the opposite Side of the Sun for the space of about 14 Days, have again appear'd in the Margin, and shew'd themselves taking the same Course as before. Some of these Spots have been observ'd to rise in the Limb, and having travers'd the *Disk*, and set after the space of 27 Days, have been seen to rise where they first appear'd, and so have continu'd to make four or five Revolutions, (before they were dissolv'd) which they always did in 27 Days, which proves the Sun to have a Motion round his own *Axis* in the space of 27 Days; the Motion of the Spots is from West to East.

Since the most bright Body of the Sun is not without its Spots and Blemishes, we are not

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to imagine that the Planets are clear, and without their Stains and Marks. *Jupiter*, *Mars*, and *Venus*, when look'd at thro' a Telescope, have several very remarkable ones, and it is by their Motions that we conclude the Rotation of the Planets round their Axes after the same Manner, and by the same Argument that we prov'd the Rotation of the Sun. The Body of *Venus* performs her Revolution round her Axis in the space of 23 Hours.

Mars finishes his Rotation in 24 Hours and 40 Minutes; the Earth in a Day, which we collect from the apparent Revolution of the Heavens, and of all the Stars round it in the same Time; and all these Bodies in their Rotations go the same Way from the West to the East.

Jupiter, besides abundance of Spots, has some Bands or Girdles which surround him; they are parallel to one another; but they neither preserve the same Magnitude nor Distance; but sometimes they increase, sometimes they diminish their Breadth, sometimes they approach each other, sometimes they recede from one another, and undergo several Changes.

Mercury does always keep so near the Sun with so great a shining Lustre, and the Heavens, while he is seen, is so illuminated, that there can be no Observations made to discover his Spots. And *Saturn* is so much remov'd from us more than the other Planets, that his Spots are not to be discern'd: yet it is probable that they, as well as the other Planets,

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have each a Rotation round an *Axis*, that all the Parts of their Surfaces may frequently have imparted to them the Light and cherishing Heat of the *Sun*, and may again be withdrawn from him, to receive such Changes as are proper and convenient for the Nature of each Planet.

By *Telescopes*, the Eclipses of the Satellites of *Jupiter* are observed, by which we are able to give a Solution of a Problem, which is most noble and curious in natural Philosophy, which cannot but raise our Wonder and Amazement, that is, Whether Light be propagated to us in an Instant, or if its Motion be successive, and if it takes some Time to come from the *Sun* to our Earth? Now these Eclipses do shew us that there is no instantaneous Motion in Light, tho' it comes from the Heavens to us with a prodigious quick Motion.

For if the Motion of Light were in an Instant, when the Earth is in that Part of its Orbit next to *Jupiter*, (see Plate 6. Fig. 15.) an Astronomer here would observe an Eclipse of a Satellite at the same Moment of Time he would do were the Earth in the opposite Point of its Orbit, and in its greatest Distance from *Jupiter*, for, according to this Hypothesis, Light is propagated in the same Instant, thro' all Spaces indefinitely, whether near or never so much remote. But if Light takes up any Time for its Propagation thro' Space, it will sooner pass through a shorter Space

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than a greater ; and therefore an Observer, when the Earth is in that Part of its Orbit next to *Jupiter*, will see an Eclipse of a Satellite sooner than a Spectator can do in the opposite Part of the Earth's Orbit. These quicker and slower Returns of Eclipses having been observed, for many Years, by Mr. *Romer*, with much Care and Diligence, upon them he founded his Argument for demonstrating the successive Propagation of Light, and by them he proved that Light, like all other Bodies in Motion, had a determined Degree of Velocity, and took a determined Time to move through a given Space ; to which Opinion the most Part of the Astronomers do now give their Assent.

The Particles therefore of Light, tho' their Minuteness be indefinite, and not easily to be imagined, yet they have a progressive rectilinear Motion, and are not diffused, as by the Waves of any Medium or Fluid. The great Sir *Isaac Newton*, in his *Principia*, determines the Velocity of Light to be such, that it reaches us here from the *Sun* in about 7 Minutes, but that Distance is reckon'd to be 81,000,000 of Miles, which Space Light passes through in so small a Time, that so prodigious a Velocity cannot easily be conceived by us, which so much exceeds the Velocity of the swiftest Bodies we know.

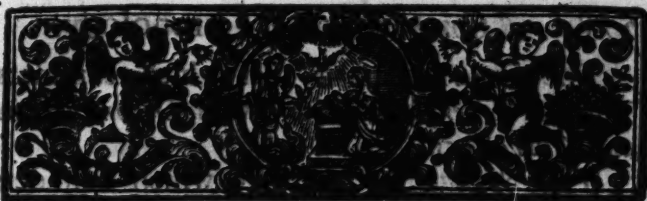
From the Eclipses of *Jupiter's Moons* we have likewise this Advantage, that when they are observed in different Places of the *Earth*,
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the Longitude of Places are by such Observations determined : For if an Eclipse of one of *Jupiter's* Moons be observed at the Royal Observatory at *Greenwich*, suppose at Twelve a Clock at Night, and if the same Eclipse be observed at *Constantinople* at Two in the Morning, from that Observation it would appear, that *Constantinople* lies 30 Degrees to the East of *London*, for every Hour's Difference of Time is equal to 15 Degrees of the Equator, therefore equal to 15 Degrees of Longitude ; but if the same Eclipse had been observed in some other Place, and the Observer had found it to happen at 10 in the Evening, the Place of that Observer would have been 30 Degrees to the West of the Meridian of *London*; for all those to the West of the Meridian of *London* have their Time later than those at *London*, and all those Places that lie upon the East Side of the Meridian of *London* have their Time sooner than those at *London*; for every 15 Degrees of the Equator is equal to an Hour of Time sooner or later, according as they are on the East or West Side of the Meridian of *London*; therefore, if the Eclipses of *Jupiter's* Moons were calculated for the Meridian of *London*, and the Reflecting Telescope improved so as to be manageable at Sea, it is evident that thereby the Longitude at Sea might be observed, only by observing of the Time of those Eclipses happening where the Ship and Observer is, and then comparing the Time of

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those Observations with Ephemerides of the Motions and Eclipses of *Jupiter's* Moons accurately computed for the Meridian of *London*, or any other Meridian; the Difference between the Time of Observation and that in the Ephemerides, reduced to Degrees by allowing 15 Degrees for every Hour, would give the Difference of Longitude. Upon Land those Eclipses are easily observed, and if they could be as easily observed at Sea, the Art of Navigation would be brought almost to Perfection, and liable to no Errors in Computation; but at Sea, the Motions and Tossings of the Ship render all Observations of such Eclipses impracticable: These are some of the most valuable Uses of Telescopes, but a vast many others might be instanc'd, which, for Brevity's Sake, we are obliged to omit.





A
COMPENDIUM
OF
CHRONOLOGY.

SECT. I.

*Of the several Parts of Time, as
divided into Hours, Days, and
Months.*

CHRONOLOGY is that Science which treats of Time, or the Arithmetical Computation of Time for Historical Uses, so as thereby truly to date the Beginning and Ending of Princes Reigns; the Revolutions of Empires and Kingdoms, Battles, Sieges, or any other memorable Action. It is divided into two Parts, viz. General and Special.

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The *General Part* is that which considers Time in *General*, with its divers *Denominations* and *Characters*.

The *Special Part* is that which considers Time in particular, by *demonstrating* the Certainty of Epochas, and taking a *View* of the *Calendars* or *Fasti* of divers *Nations*.

The most considerable *Parts* of *Time*, are *Hours*, *Days*, *Months*, and *Years*.

A *Day* is a Space of *Time* wherein the *Sun* by his apparent *Motion*, either describes a certain Part of a *Circle*, or makes an intire *Revolution*, and is either *Natural* or *Artificial*.

A *Natural Day* is the *Duration* of an intire apparent *Revolution* of the *Sun* about the *Earth*.

The *Artificial* is that Part of the *Natural Day*, in which the *Sun* continues above the *Horizon*, and is opposite to the *Night*, being that Part of *Time* which the *Sun* is under the *Horizon*; but the *Natural Day* contains both.

The *Natural Day* is either *Astronomical* or *Civil*; the *Astronomical Day* is the Space of *Time* that flows between the *Sun's* leaving a given *Meridian* and the next Return to the same; that is, the Space of *Time* wherein a *Revolution* of the whole *Cœlestial Equator* is performed, and of that Part of it besides which answers to 59 Minutes, 8 Seconds of the *Ecliptick*, the *Sun's* Mean Motion in one Day; for when the Degree of the *Equator* the *Sun* was in, when last at the *Meridian*, together with the Degree of the *Ecliptick* opposite

to it, are again arriv'd at the *Meridian*, the Sun has not reach'd it; for while the Earth by its *Motion* round its Axis, has made the *Diurnal Phænomena* of the Revolution of the Equator, the Sun in his apparent Annual *Motion* having moved almost a Degree towards the *East*, therefore a small Portion of *Time* must be allowed more than the *Revolution* of the Equator, to compleat an *Astronomical* or *Natural Day*; and by reason of the Inequality of the apparent *Motion* of the Sun, together with the Obliquity of the *Ecliptick*, which makes the *Arch* of the Equator answering to the several Degrees thereof unequal; therefore that additional Part of *Time*, which is every Day to be added to the *Revolution* of the Equator, to compleat the Time of the Sun's departing from any one *Meridian* till his Return to the same again, must be unequal; and from this arises the Inequality of *Natural Days*.

The *Natural Day* is called *Civil*, because it is by divers Nations reckon'd divers Ways: The *Babylonians* began to account their Day from Sun rising; the *Jews* and *Athenians* from Sun setting, whom the *Italians* follow to this Day; the *Egyptians* begin at *Midnight*, which is the Custom of the *British*, *French*, and *Germans*, with several other *European Nations*: But most *Astronomers* begin their Day at *Noon*.

An Hour is commonly called the 24th Part of a Day, it being that by which the whole

Time of *Night* and *Day* is divided into 24 equal Parts: But unequal *Hours* are those by which the Time of the *Artificial* Day is always divided into 12 equal Parts, and the *Nights* into as many. It is called *Temporary*, because of a various Length in different Times or Seasons of the Year; thus, the Summer Diurnal *Hour* is longer than that of Winter, and the Winter Nocturnal *Hour* longer than that of Summer. At the Time of the *Equinoxes* the Nocturnal and Diurnal *Hours* are equal; and to all those that live on the *Equator*, they are always equal, also to those that live nigh to the *Equator*, their Inequality is but small.

The equal *Hours* were always used by *Astronomers*, and are now in use among almost all Nations, and are subdivided into 60 equal Parts called *Minutes*, and each *Minute* into 60 equal Parts called *Seconds*. Such as begin to account the *Hours* of the Civil Day from *Morning* or *Evening*, do it because the *Sun* is then in the *Horizon*, the most perceptible of all the *Circles* of the *Sphere*.

A *Month* is that Part of *Time* by which we usually divide a *Year* into 12, or into 13 Parts, and is either *Astronomical* or *Civil*.

Astronomical Months are those that are measured by the *Motion* of the *Luminaries*, and are therefore divided into *Lunar* and *Solar Months*.

Again, A *Lunar Month* is either *Periodick*, in which the *Moon* having departed from any Point of the *Zodiack*, returns to the same again, and

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and consists of 27 Days 7 $\frac{1}{4}$ Hours; which is that Space of *Time* wherein the *Moon* runs thro' all her several Phases, and on that account is of *principal* use in the marking out of *Time*. The Difference between a *Periodical* and *Synodical* Month is this; the first is called *Periodical*, only in respect to the *Moon's* Orbit, but the *Synodical* is so called, in respect of her *Conjunction* with the *Sun*: Now after the Time of her *Conjunction*, the *Sun* does not continue in the same Place of the *Ecliptick*, but moves forward towards the *East*; upon which it happens, that the *Moon* finishing her Course, does not find the *Sun* again in the same Point where she left him, he being removed almost a whole *Sign* from his former Place, so that to overtake the *Sun* again, it plainly appears, that a certain Space of *Time* is requisite besides the *Periodical*, which makes up the *Synodical* Month. The *Quantity* of a *Synodical* Month is not the same at all Times, for in Summer when the *Sun* seems to move slowest, the *Synodical* Month appeareth less than in Winter, when the *Sun's* Motion appears swifter, the *Moon* not overtaking the *Sun* so soon.

The *Solar* Month is that Space of *Time* wherein the *Sun* appears to run thro' one of the 12 Signs of the *Zodiack*, by his Motion from *West* to *East*, among which Months there is very great Inequality, because the *Sun* in *Cancer* seems to us to move slower, for which Reason the Month of the Summer *Solstice* contains

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contains near 31 Days 11 Hours; but in *Capricorn* the Motion of the *Sun* appears more *swift*, the *Solar Month* then consisting only of about 29 Days, 8 Hours; the Mean Quantity therefore of every *Solar Month* will be about 30 Days 10 Hours, that is, when the *Sun* is in the *Equinoctial Signs*.

The *Civil* or *Political Month* is a System of Days, which different *Nations* differently observe in their *Civil Affairs*, according to their voluntary *Institutions*; for some, as the *Agyptians*, liked the *Solar Months*, and made each of them to consist of 30 Days, and to compleat the *Year*, at the End of 12 such *Months*, they annexed 5 Days, made up of those Hours that arise from the 10 Hours, that each *Solar Month* exceeds 30 Days.

But most of the *Ancients* fancied the *Synodic Lunar Months* most; such as the *Jews*, the *Grecians*, and *Romans*, to *Julius Cæsar's* Time, and the *Mahometans* at this Time; but that those sort of *Lunar Months* that do not consist of whole Days, might be fitted to *Civil Use*, they divided the odd Hours so, as to make their *Civil Months* alternately to consist of 30 and 29 Days; so that two such *Months* ate equal to two *Lunar Months* of $29\frac{1}{2}$ Days each, and the New Moon would not remove from the first Day of the *Civil Month* in the Space of some *Years*.



SECT. II.

Of the Division of Time into Years.

A Year is a certain Space of Time, the Parts of which are commonly called Months, and is either *Astronomical* or *Civil*.

The *Astronomical Year* is also two-fold, namely, the *Sydereal* and *Tropical*.

The *Sydereal Year*, is that Space of Time that the Sun having departed from a fixed Star returns to the same again, being 365 Days. 6 Hours, and 10 Minutes nearly. The *Tropical Year* is that wherein the Sun departing from one of the *Cardinal* Points, viz. the *Equinox*, or *Solstice*, returns to it again, and is something less than the *Sydereal*, because the *Cardinal* Points of the *Ecliptick* themselves go backwards about 50 Seconds of a Degree, as it were meeting the Sun, which makes the Sun return to the same Point of the *Ecliptick* about 21 Minutes of the Time sooner than to the same fixed Star where that Point of the *Ecliptick* was, when the Sun was before in the said Point: Therefore the *Tropical Year* consists of 365 Days, 5 Hours, and $48\frac{1}{2}$ Minutes very near. But whereas the Hours and Minutes

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Minutes above the whole *Days* of a *Solar Year*, cannot be taken Notice of in *Civil* or common Use; therefore the *Civil* or *Solar Year* in use among us, is made to consist only of 365 *Days*, for three *Years* together, and every fourth *Year* of 366 *Days*, the *Solar Year* having 5 *Hours* 49 $\frac{1}{2}$ *Minutes* very near above the whole *Days*, there are added every *Year* about 11 *Minutes* to make 6 *Hours*, and these 6 *Hours* amount just to a whole *Day* in four *Years*.

The *Civil Lunar Year* consists of 12 *Lunations* or *Synodick Months*, which is finished in 354 *Days*, at the End of which, the *Year* begins again. It has this Inconveniency, that the same *Months* in several *Years* have not the same Season; the Occasion of which is, that the *Lunar Years* being less than the *Solar* by almost 11 *Days*, in three *Years* time, every *Month* will have the Season of that *Month* which went before it; hence it is, that the Beginning of this *Year* falling upon the *Spring* now, in 8 *Years* Time would fall upon *Winter*, and 8 *Years* after that, would begin in *Autumn*, then in *Summer*; and lastly, at the End of 33 *Years*, return to the *Spring* again, and this is called the wandering *Lunar Year*, because its Beginning wanders thro' all the Seasons of the *Year*. This *Year* is in Use among the *Turks*; but the *Jews*, who follow the *Moon's Motion* in their Accounts, retain still the same Seasons in the same *Months*, for as often as there is the Difference of 30 *Days* between the common

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mon *Lunar Year* and the *Solar Year*, they intercalate a *Month*, by which Means the *Lunar* and *Solar Years* are kept so adjusted one to the other, as that the *Lunar Year* will keep in a manner fixed to the same Part of the *Solar Year*.

All Nations, before the just Length of the *Solar Year* was known, reckoned Months by the Course of the *Moon*, and Years by the Returns of Winter and Summer, Spring and Autumn: And in making *Calendars* for their Festivals, they reckoned thirty Days to a Lunar Month, and twelve Lunar Months to a Year, taking the nearest round Numbers; whence came the Division of the *Ecliptick* into 360 Degrees; so in the time of *Noah's Flood*, when the *Moon* could not be seen, *Noah* reckoned thirty Days to a Month; but if the *Moon* appeared a Day or two before the End of the Month, they began the next Month with the first Day of her Appearing: And this was done generally, 'till the *Egyptians* of *Thebais* found the Length of the *Solar Year*.

The ancient Calendar Year of the *Greeks* consisted of twelve Lunar Months, and every Month of thirty Days; and these Years and Months they corrected from Time to Time, by the Courses of the *Sun* and *Moon*, omitting a Day or two in the Month, as often as they found the Month too long for the Course of the *Moon*; and adding a Month to the Year, as often as they found the twelve Lunar Months

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Months too short for the Return of the four Seasons. *Cleobulus*, one of the seven wise Men of Greece, alluded to this Year of the Greeks, in his Parable of one Father who had twelve Sons, each of which had thirty Daughters, half white and half black: And *Tbales* called the last Day of the Month the thirtieth, calling that Day the *old* and the *new*, or the last Day of the *old Month*, and the first Day of the *new*: For he introduced a Month of 29 and 30 Days alternately, making the thirtieth Day of every other Month to be the first Day of the next Month.

To the twelve *Lunar Months*, the ancient Greeks added a thirteenth, every other Year, which made their *Dieteris*; and because this Reckoning made their Year too long by a Month, in eight Years, they omitted an *intercalary Month*, once in eight Years, which made their *Oſtaeteris*, one half of which was their *Tetraeteris*: And these Periods seem to have been almost as old as the Religion of Greece, being used in divers of their *Sacra*. The *Oſtaeteris* was the *Annus Magnus* of *Cadmus* and *Minos*, and seems to have been brought into Greece and Crete by the *Phœnicians*, who came thither with *Cadmus* and *Europa*, and to have continued till after the Days of *Herodotus*: For in counting the Length of seventy Years, he reckons thirty Days to a *Lunar Month*, and twelve such Months, or 360 Days, to the ordinary Year, without the *intercalary Months*, and 25 such Months

Months to the *Dieteris*. And according to the Number of Days in the *Calendar Year* of the *Greeks*, *Demetrius Phaleteus* had 360 Statues erected to him by the *Athenians*. But the *Greeks*, *Cleostratus*, *Harpalus*, and others, to make their Months agree better with the Course of the *Moon*, in the Time of the *Persian Empire*, varied the Manner of intercalating the three Months in the *Oftaeteris*; and *Meton* found out the *Cycle* of intercalating seven Months in nineteen Years.

The ancient Year of the *Latins* was also *Luni-solar*; for *Plutarch* tells us, that the Year of *Numa* consisted of twelve *Lunar Months*, with *intercalary Months* to make up what the twelve *Lunar Months* wanted of the *Solar Year*. The ancient Year of the *Egyptians* was also *Luni-solar*, and continued to be so till the Days of *Hyperion*, or *Osiris*, a King of *Egypt*, the Father of *Helius* and *Selene*; for the *Israelites* brought this Year out of *Egypt*: And *Diodorus* tells us, that *Ouranus*, the Father of *Hyperion*, used this Year; and that in the Temple of *Osiris*, the Priests appointed thereunto, filled 360 Milk Bowls every Day; I think he means one Bowl every Day, in all 360, to count the Number of Days in the *Calendar Year*, and thereby to find out the Difference between this and the true *Solar Year*; for the Year of 360 Days was Year, to the End of which they added the five Days. That the *Israelites* used the *Luni-solar Year*, is beyond
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Question. Their Months began with their *New Moons*. Their first Month was called *Abib*, from the Earing of Corn in that Month. Their Passover was kept upon the fourteenth Day of the first Month, the *Moon* being then in the Full: And if the Corn was not then ripe enough for offering the first Fruits, the Festival was put off, by adding an *intercalary Month* to the End of the Year; and the Harvest was got in before the *Pentecost*, and the other Fruits gather'd before the Feast of the seventh Month.

Simplicius, in his Commentary on the first of *Aristotle's Physicat Acroast's*, tells us, that some begin the Year upon the *Summer Solstice*, as the People of *Attica*; or upon the *Autumnal Equinox*, as the People of *Asia*; or in *Winter*, as the *Romans*; or about the *Vernal Equinox*, as the *Arabians* and People of *Damascus*. And the Month began, according to some, upon the *Full Moon*; or upon the *New*. The Years of all these Nations were therefore *Luni-solar*, and kept to the four Seasons: And the *Roman Year* began at first in *Spring*, as appears from the Names of their Months, *Quintilis*, *Sextilis*, *September*, *October*, *November*, *December*: And the Beginning was afterwards removed to *Winter*. The ancient *Civil Year* of the *Affyrians* and *Babylonians* was also *Luni-solar*: For this Year was also used by the *Samaritans*, who came from several Parts of the *Affyrian Empire*; and the *Jews*, who came from *Babylon*,

Babylon, called the Months of their *Lunisolar Year*, after the Names of the Months of the *Babylonian Year*: And *Berosus* tell us, that the *Babylonians* celebrated the Feast *Sacæa* upon the 16th Day of the Month *Lous*, which was a *Lunar Month* of the *Macedonians*, and kept to one and the same Season of the Year: And the *Arabians*, a Nation who peopled *Babylon*, use *Lunar Months* to this Day. *Suidas* tells us, that the *Sarus* of the *Chaldeans* contains 222 *Lunar Months*, which are 18 Years, consisting each of twelve *Lunar Months*, besides six *intercalary Months*: And when *Cyrus* cut the River *Gindus* into 360 Channels, he seems to have alluded unto the Number of Days in the *Calendar Year* of the *Medes* and *Persians*.

At length the *Egyptians*, for the sake of *Navigation*, applied themselves to observe the *Stars*; and by their *Heliacal* Risings and Settings, found the true *Solar Year* to be five Days longer than the *Calendar Year*, and therefore added five Days to the twelve *Calendar Months*; making the *Solar Year* to consist of twelve Months and five Days. *Strabo* and *Diodorus* ascribe this Invention to the *Egyptians* of *Thebes*. The *Theban Priests*, saith *Strabo*, are, above others, said to be *Astronomers* and *Philosophers*: They invented the reckoning of Days, not by the Course of the Moon, but by the Course of the Sun: To twelve Months, each of thirty Days, they add yearly five Days. In Memory of this Emendation of

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the *Year*, they dedicated the five additional Days to *Osiris*, *Isis*, *Orus Senior*, *Typhon*, and *Nephtke*, the Wife of *Typhon*, feigning that those Days were added to the Year when these five Princes were born; that is, in the Reign of *Ouranus*, or *Ammon*, the Father of *Sesac*: And in the *Sepulchre* of *Amenophis*, who reigned soon after, they placed a golden Circle of 365 Cubits in Compass, and divided it into 365 equal Parts, to represent all the Days in the Year, and noted, upon each Part, the *Heliacal* Risings and Settings of the *Stars* on that Day; which Circle remained there till the Invasion of *Egypt* by *Cambyfes*, King of *Persia*. Till the Reign of *Ouranus*, the Father of *Hyperion*, and Grandfather of *Helius* and *Selene*, the *Egyptians* used the old *Luni-solar Year*: But in his Reign, that is, in the Reign of *Ammon*, the Father of *Osiris*, or *Sesac*, and Grandfather of *Orus* and *Bubaste*, the *Thebans* began to apply themselves to *Navigation* and *Astronomy*, and by the *Heliacal* Risings and Settings of the *Stars*, determined the Length of the *Solar Year*; and to the old *Calendar Year* added five Days, and dedicated them to his five Children above mentioned, as their Birth-days. And in the Reign of *Amenophis*, when by further Observations they had sufficiently determined the Time of the *Solstices*, they might place the Beginning of this *New Year* upon the *Vernal Equinox*. This Year being at last propagated into *Chaldea*, gave Occasion to the
Year

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Year of Nabonassar; for the Years of *Nabonassar*, and those of *Egypt*, began on one and the same Day, called by them *Thoth*, and were equal, and, in all respects, the same: And the first Year of *Nabonassar* began on the 26th Day of *February* of the old *Roman Year* Seven Hundred Forty and Seven Years before the vulgar *Æra of Christ*.

The *Turks* and *Arabians* make use of the *Lunar Year*, somewhat adapted to *Civil Use*; and the same Custom is also observed in *Tartary*, *Siam*, and *Japan*, and some other Places.

Political or *Civil Years* are used in the Regulation of *Civil* or *Ecclesiastical Affairs*, and in adjusting their Measure, Regard is had to the *Motion* of the *Luminaries*.

There are several Sorts of *Civil Years*, among which, that called the *Julian* is the most celebrated.

It derives its Name and Institution from *Julius Cæsar*. He observing the *Ægyptian Year* to get before the *Tropical*, because the 6 Hours it wants of the *Tropical* are intirely neglected in its Constitution, did therefore add those 6 Hours to each *Julian Year*, so that a *Julian Year* consists of 365 Days, 6 Hours; and because this Quarter of a Day cannot be considered or taken Notice of in *Civil Use*, he ordered the 6 Hours to be neglected till they made a Day, which happening every 4th Year was to be inserted, by way of *Intercalation*, between the 23d and 24th of *February*;

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therefore from that Time they write the sixth of the *Calends of March* twice, from which the *Year* had the Name of *Bissextile*. And this *Julian Year* of 365, and every 4th Year 366 Days, is the best fitted for *Astronomical Computations*, because it is a Mean between the *Natural* or *Tropical Year* of 365 Days, 5 Hours, and 49 Minutes, and the *Sydereal Year* of 365 Days and 10 Minutes; and does, as it were, give an *Ocular Demonstration* of the *Equinoxes*. But this *Julian Year*, the Quantity of it must be own'd to be too big, on which Account the Beginning of this *Year* also, by little and little, creeps forwards in regard of the *Seasons*, or (which is all one) the Times of the *Equinoxes* and *Solstices* go backward in regard of the Days of this *Year*. And since this Regress is about $10 \frac{1}{4}$ Minutes every Year, in about 133 Years it will be about a Day, and consequently from the *Year of Christ* 325, wherein the *Council of Nice* was held, to the *Year* 1582, wherein *Pope Gregory* reform'd the *Calendar*, this Regress amounted to 10 Days. Hence it came to pass, that whereas in the Time of the *Nicene Council*, the *Vernal Equinox* happened near about the 21st of *March*, in the *Year* 1582, it was found to be about the 11th of *March*; that *Pope Gregory* might therefore bring the *Equinox* to its former Place, 10 Days were suppressed in the Month of *October* in the *Year* 1582, and the 5th Day was called the 15th; by this Means, what would otherwise have been the 11th of the

the

the *March* following, became the 21st of *March*; That is, the *Equinox* happens the same Day as it did in the Time of the *Council of Nice*. And that the like *Variation* might not happen again, the said *Pope* ordered, that once in 133 Years, a Day should be taken out of the *Calendar*, or (which comes to the same) that 3 Days should be taken out every four hundred Years; and this he appointed to be done, by making every hundredth Year of the *Christian Era* common, which according to the *Julian Account* is always *Bissextile*, but every four hundredth Year to continue *Bissextile* as in the *Julian Account*. This Form of the Year settled by *Pope Gregory XIII.* was call'd from him the *Gregorian*, and is observed in *Italy, France, Spain, Germany*, and wheresoever the *Authority* of the *Pope* reaches.

As the Form of the Year among different Nations is various, so likewise is its Beginning: The *Jews* begin their *Ecclesiastical Year* with the *New Moon* of that Month, whose *Full Moon* happens next after the *Vernal Equinox*: The *Church of Rome* begin their Year with the *Sunday* that happens next after the said *Full Moon*, or with the *Feast of the Resurrection* of our *Lord*.

The *Jews* begin their *Civil Year* with the *New Moon* that has its *Full Moon* happening next after the *Autumnal Equinox*.

The *Grecians* begin their Year with the *New Moon* that happens next after the *Sum-*

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mer *Solstice*. The *Romans* anciently began theirs with the *New Moon* that happens next after the *Winter Solstice*, and this seems to be the Reason why *Julius Cæsar* fix'd the Beginning of his *Year* to the *Calends* of *January*.

The more celebrated Collections of *Years*, or *Times* measured by a *Repetition* of *Years*, are an *Olympiad* of 4 *Years*, a *Jubile* of 49 or 50 *Years*, and an *Annus Magnus*, or great *Year*, standing for an intire Revolution of the fixed *Stars*; till after having departed from a fixed Point, they return to the same again, which is 25000 or 26000 *Years*. And thus much for the several Parts into which Time in general is distinguished.



SECT.



S E C T. III.

Of the Cycle of the Moon.

THE *Lunar Cycle* is a *System* of 19 Years, in which Time the *New Moons* return to the same Days they were on before, and she begins again her Course with the *Sun*.

This was begun by *Melon* the *Athenian*, and is called the *Golden Number*; for supposing the *Sun* and *Moon* to be in *Conjunction* the first Day of the *Year*, at the End thereof, the *Moon's* 12 Months will be finished 11 Days sooner than that of the *Sun*, so she will be at the End of the *Sun's* Year, 11 Days before him, and in 2 Years 22 Days before him, &c.

All these *Variations* are finished in 19 Years, nearly agreeing with the Course of the *Nodes* of the *Moon*; that is, the Points where her *Orbit* crosses the *Ecliptick*.

If the *Lunations* be observed and set down for a whole Course of the *Golden Number* or Cycle of 19 Years, which is the Cycle of the *Moon*, the same Observations will serve thro' the next Cycle of 19 Years, and will continue so for some Time, and therefore the *Golden*

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Number in the first Column of the Calendar before the Book of Common Prayer, shews the Days of the Month the New and Full Moons happen on.

The *Antients* did imagine that the *Cycle* of 19 *Years* did exactly compleat 235 *Lunations*, and therefore after the *Revolution* of that *Time*, the *New Moons* not only fall on the same *Days* of the *Month*, but likewise on the same *Hours* of the *Day*, which is not true; for in 19 *Julian Years*, there are 6939 *Days* and 18 *Hours*: But allowing to every *Lunation* 29 *Days*, 12 *Hours*, 44 *Minutes*, 3 *Seconds*, which the *Motion* of the *Moon* requires, 235 such *Lunations* will make 6939 *Days*, 16 *Hours*, 31 *Minutes*, 45 *Seconds*: Therefore 235 *Lunations* are not equal to 19 *Julian Years*, but are less by one *Hour* and an *Half*, and consequently the *New Moons* after 19 *Years* will not return to the same *Hour*, but will be an *Hour* and an *Half* sooner, and in 304 *Years* they will anticipate a whole *Day*. And therefore the *Golden Number* will, precisely enough for common *Use*, shew the *Lunations* for the *Space* of three *Centuries*, without the *Error* of one *Day*.

At the *Council* of *Nice*, when the *Cycle* of the *Moon* was fitted to the *Calendar*, and some *Centuries* afterwards, it did nearly enough give the *Time* of the *New Moons*: But the *Lunations* in every 300 *Years* anticipating a whole *Day*, they now happen almost five *Days* sooner than they should do according
to

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to the Rule of the *Golden Number*. Notwithstanding this, the *Church of England* retains the Way of computing by the *Golden Number* as it was disposed in the *Calendar* at the Time of the *Nicene Council*, and the *new Moons* computed after that manner are called *Ecclesiastical new Moons*, to distinguish them from the true ones in the *Heavens*; and the *general Table*, or *Rule* for finding *Easter* for ever, which is in our *Liturgy*, by the *Golden Number* and *Dominical Letter*, is made according to that Disposition of the *Golden Number*.

In the first Year of the *Christian Æra*, 2 was the *Golden Number*, and therefore, if to the current Year of *Christ* we add one, and divide that Sum by 19, the *Remainder* is the *Golden Number*, and if nothing remain, 19 is the *Golden Number* for that Year.

E X A M P L E.

Let the *Golden Number* for the Year of our Lord 1729 be required.

To	-	-	-	-	-	-	1729
Add	-	-	-	-	-	-	1

The Sum divide by 19)1730(91

171

20

19

The Remainder is	-	-	-	1
------------------	---	---	---	---

There-

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Therefore 1 is the *Golden Number* required, and the *Quotient* 91 shews that there has been so many *Revolutions* of the Cycle of the Moon since the Birth of *Christ*, or the Beginning of the *Christian Æra*.



S E C T. IV.

Of the E P A C T S.

UNDER the Name of *Epacts* we usually understand the Difference between a *Lunar* and a *Julian Year*; for the common *Lunar Year* not being equal to, but less than the *Julian*, and both being made use of in the *Ecclesiastical* Computation. some *Authors* bethought themselves of reducing the one to the other.

It has been observed in the preceding Section, that the *Civil Lunar Year* is 41 Days shorter than the *Solar*: Consequently two such *Lunar Years* will be 22 Days, and three *Lunar Years* will be 33 Days shorter than three *Solar Years*. Now those that use the *Lunar Year*, in order to adjust it to the *Solar*, as often as the *Lunar Year* comes to be 33 Days shorter

shorter than the *Solar*, do intercalate a Month of 30 Days into the *Lunar Year*, and by this means the *Civil Lunar* and *Solar Years*, are kept so adjusted to one another, as that the first Year of the Moon's Cycle comes not shorter of the *Solar Year* than 11 Days, the second Year not shorter than 22 Days, and the third Year than 33 Days.

And as the *New Moons* fall on the same Day every 19th Year, so the Difference between the *Solar* and *Lunar Year* is the same every 19th Year; and because the said Difference is always to be added to the *Lunar Year*, in order to adjust or make it equal to the *Solar Year*, hence, the said Difference respectively belonging to each Year of the *Moon's Cycle* is call'd the *Epact* of the said Year, that is, the Number to be added to the said *Lunar Year*, to make it equal to the *Solar Year*.

To find the *Epact* for any Year, multiply the *Golden Number* (that is, the Cycle of the Moon) for that Year by 11, the Product, if less than 30, is the *Epact* sought; if the Product be greater than 30, divide it by 30, and the Remainder is the *Epact* for the *Julian Account*. The *Epact* for the *Julian Account* being known, the *Epact* for the *Gregorian Account* may easily be found; thus, if the *Julian Epact* be greater than 11, subtracting 11 from it, leaves the *Gregorian*; but if the *Julian Epact* be less than 11, add 30
to

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to it, and from that Sum *subtract* 11, the Remainder will be the *Gregorian Epact*.

The Day of the *Month* the *new Moon* falls on, may be known by the Help of the *Epact*, thus; To the Number of the *Months* from *March* *inclusively*, add the *Epact* of the given *Year*, if the Sum be less than 30, *subtract* it out of 30; but if *greater*, *subtract* it out of 60, and the Remainder will be the Day on which the *new Moon* falls.

E X A M P L E.

Let the *Epacts* for the *Julian Account* for the Year 1729 be required :

The *Golden Number* for the Year is 1

Which multiplied by - - - 11

11

Gives 11, the *Epact* required.





SECT. V.

*Of the Cycle of the Sunday-Letter,
commonly called the Cycle of the Sun.*

THE *Weekly Character* is that whereby we distinguish one Day of the *Week* from another: The *Week* is a System of 7 Days continually returning, and to this End *Divinely ordained*, that the *Memory* of the Six Days *Creation* might be preserved. We describe the Days of the *Week* by Seven different Names; as, *Sunday, Monday, Tuesday, &c.* and to distinguish them in the *Calendar*, there are *Seven Letters* appropriated, and set in *Alphabetical Order* before them, and so repeated throughout the whole *Year*, viz. A, B, C, D, E, F, G, and some one of these is the *Dominical Letter*, or the *Letter* for *Sunday*, and the *Letters* following, for the other Days of the *Week*.

The *Sunday Letter* is not always the same, but is *changed* once every common *Year*, and twice in every fourth, or *Leap-Year*. The Reason is, first, because the common *Year* does not consist of intire *Weeks*, but of 52 *Weeks*
and

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and one Day; so that the *Year* beginning with A, prefix'd to *New-Year's Day*, it will likewise end with A, prefix'd to the last Day; and the *Year* beginning again with A, there will be two A's falling together, viz. *December 31*, and *January 1*, and if one of them, i. e. the former, happen to be *Sunday*, the other in Course must stand for *Monday*, and then *Sunday* must fall upon the preceding G, which will be the *Dominical Letter* for the ensuing *Year*; thus, the odd Day shifts back the *Dominical Letter* every Year by one Letter, and this *Revolution* would be performed in seven *Years*; but there comes in another odd Day every fourth *Year*, being *Leap-Year*, in which the *Sunday-Letter* is changed twice; once at the Beginning of the Year, and once towards the latter End of *February*, by Interposition of the Intercalar Day called *Bissexile*, because the 6th of the *Calends* of *March* is twice repeated.

To take a more easy Account of these Changes, there is appropriated a Cycle which comprehends, in order, all the *Variations* of the *Sunday-Letter*, and is therefore called the Cycle of the Sun, composed of four, the Changes which make the *Leap-Year*; and of seven, the Changes of one Day throughout the *Week*, which 4 times 7, or 28 *Years*, compleat all the Varieties of the *Dominical Letters*.

The *Dominical Letters* shifting in a Retrograde Order, it follows, that if this Year have G for its *Dominical Letter*, F will answer

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swer to the next, and in *Leap-Years*, which have Two *Dominical Letters*, the one serving for *January* and *February*, and the other for all the rest of the Year, the same *Retrograde Order* is observed.

To find the *Dominical Letter* for any Year of our Lord: The Year proposed divide by 4, (neglecting the Remainder) add 4 to the *Quotient*, which Sum add to the same Year proposed, and that Sum divide by 7; if nothing remain, G is the *Dominical Letter* for that Year; but if there be any Remainder, *Subtract* it from 7, and that Remainder will shew the Number of the *Dominical Letter* from the Beginning of the *Alphabet* for that Year. The *Sunday-Letter* being known, it is easy, by the Help of the following Verses, to tell what Day of the *Week* the first Day of any *Month* falls upon; the Order of the Words answering to the Order of the *Month*, runs thus,

<i>Jan.</i>	<i>February,</i>	<i>March,</i>	<i>April,</i>	<i>May,</i>	<i>June,</i>
<i>At</i>	<i>Dover</i>	<i>dwells</i>	<i>George Brown,</i>	<i>Esquire,</i>	
<i>July,</i>	<i>August,</i>	<i>Sept.</i>	<i>Octob.</i>	<i>Nov.</i>	<i>Dec.</i>
<i>Good</i>	<i>Christopher</i>	<i>Finch</i>	<i>and</i>	<i>David</i>	<i>Fryer.</i>

I would know what Day of the *Week* *July* the First 1725 falls upon. The *Sunday Letter* for that Year being C, by the foregoing Verses I know G is the Letter belonging to *July* first, which in *Alphabetical Order* is the fourth Letter from the *Dominical Letter* C,
and

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and therefore *July* begins on *Thursday* the fourth Day after *Sunday*, because G in the Order of the Alphabet is after the *Dominical Letter C*.

Also if the Day of the Week *March* the 1st falls upon the Year 1729; the *Sunday Letter* being E, and by the preceding Verses *d* is the *Letter* for *March* the first, and is one Letter contrary to Alphabetical Order removed from E, the *Sunday Letter*; therefore *March* the first falls on *Saturday* for the Year proposed.



S E C T. VI.

Of the Roman Indiction, and Julian Period.

THE Cycle of *Indiction* is a System of 15 *Julian Years* perpetually returning, by which the Times of certain *Payments* were made known to the *Roman Subjects*. When this Cycle was first instituted is uncertain, but it is evident from *History*, that it has been in use ever since *Constantine the Great*, or from the Year of our Lord 312.

There

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There are commonly reckon'd three Sorts of *Indictions*, whereof the first was called the *Cæsarian*, because the *Cæsars* had Respect to it in the *Payment of Taxes*; this *Indiction* fell on the 8th of the *Calends of October*.

The second was called *Constantinopolitan*, by which they marked the more *Oriental Calendars*. This began on the *Calends of September*, whence some think that its Use began when the *Grecians* chose the *Autumn*, and the first Month of it for the Solemnity of the New Year.

The third is called the *Pontifical* which begins upon the *Calends of January*, and continually follows the two former, at the *Distance* of almost four *Months*. This *Indiction* is still used by the *Pope* in his *Bulls*; &c. The Year of the *Roman Indiction*, answering to any given Year of *Christ*, is found by adding 3 to the given Year of *Christ*, and dividing the Sum by 15, the Remainder shews the *Indiction*; but if nothing remains, it is the 15th or last Year of the *Indiction*:

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E X A M P L E.

Let the Year of the *Christian Æra* 1729 be given to find what Year the *Roman Indiction* answers thereto.

$$\begin{array}{r}
 \text{The given Year} \quad - \quad - \quad 1729 \\
 \text{To which add} \quad - \quad - \quad 3 \\
 \hline
 \text{Divide by} \quad - \quad - \quad 15 \quad 1732(115 \\
 \hline
 15 \cdot \\
 \hline
 25 \cdot \\
 15 \\
 \hline
 82 \\
 75 \\
 \hline
 7
 \end{array}$$

The Remainder 7 is the Number of the *Cycle* of the *Roman Indiction* for that Year, and the Quotient 115 shews the Number of Revolutions of the said *Indiction*, since the Beginning of the *Christian Æra*.

The *Julian Period*, is a System of 7980 Years, and arises from the continual *Multiplication* of 19 the *Cycle* of the *Moon*, 28 the *Cycle* of the *Sun*, and 15 the *Roman Indiction*. The first Year of this Period had 1 for the *Character* of the *Solar Cycle* as well as of the *Lunar Cycle*, and of the *Indiction*. It is called the

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the *Julian Period*, because it was adapted by the Author or Inventor of it, *Joseph Scaliger*, to the *Julian Years*, in respect of its Use. This *Period* is the Standard or common Receptacle of all other *Epocha's*; so that we are chiefly to reduce all other *Aera's* to it; for every Year in this *Period* has its *peculiar Cycles*, no two *Years* in the *whole Period* having the same Numbers for all the *Cycles*; whereas, if we reckon by the Year of the *World*, we must first inquire how many *Years* any *Author* reckons from the *Creation* to the Year named, which is troublesome and full of Difficulties, according to the Method of other Periods.

To know what Year of the *Cycle* of the *Sun*, *Moon*, or *Indiction* answers to any given Year of the *Julian Period*; divide the given Year respectively by 28, or 19, or 15; the Remainder of the first Division will shew the Year of the *Sun's Cycle*; the second Remainder the Year of the *Moon's Cycle*, and the third Remainder the Year of the *Indiction*, and if nothing remains in each Division, then it is the last Year of each *Cycle* respectively.

On the contrary, to know what Year of the *Julian Period* answers to any given Year of the *Cycle* of the *Sun*, *Moon*, or *Indiction*; multiply the *Cycle* of the *Sun* into 4845, the *Moon* into 4200, the *Cycle* of the *Indiction* into 6916. The Sum of the *Products* being divided by 7980, the *Remainder*

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der will shew the Year of the *Julian Period* fought.

To find what Year of the *Julian Period* any given Year of *Christ* answers to ; to the given Year of *Christ* add 4713, and the Sum gives the Year of the *Julian Period* fought. On the contrary, having the Year of the *Julian Period* given, to find what Year of *Christ* answers thereto ; from the Year of the *Julian Period* given, subtract 4713, and the Residue will be the Year of *Christ* fought.

E X A M P L E.

Let the Year of the Christian *Æra* 1729 be given, to find what Year of the *Julian Period* answers to it,

To the given Year	-	-	1729
Add	-	-	4713
The Sum	-	-	6442

Is the Year of the *Julian Period* required.

Then to find what Year of the *Cycle* of the *Sun*, *Moon* and *Indiction* answers to the above Year of the *Julian Period* 6442 ; The given Year 6442 being divided by 28, leaves 2 for a *Remainder*, which shews that it is the second Year of the *Sun's Cycle*. Also the same given Year being divided by 19 and 15 severally, the 2 *Remainders* will be 1 and 7, which shews that

that the given Year is the first of the *Cycle* of the Moon, and the seventh of the *Cycle* of the *Roman Indiction*.

And by the same Method the Year of the *Julian Period* answering to any given Year of *Christ* may be known ; as also the Year of the *Cycle* of the *Sun*, *Moon*, and *Indiction* that answers to the same.



S E C T. VII.

Of Epocha's and Æra's.

AS the *Astronomers*, in computing the *Motions* of *Celestial Bodies*, assume certain *fixed* Points, so they do certain *Moments* of *Time*, from which, as *Roots*, their *Computations* may begin and proceed. These *Roots* are call'd *Epocha's* or *Æra's*, and commonly have a Name from some famous *Action* or *Event* that happened near the *Beginning* of each. The most *considerable*, and that with which we are best *acquainted*, is the *Epocha* of *Christ's Nativity*, or the first Day of the *January* that we suppose to follow next to the *Nativity* of our *Lord*. The *Æra*, or *Way* of *Reckoning* from *Christ*, was first introduced

roduced by one *Dionysius*, about 500 Years after *Christ*, since which Time *Christians* have reckoned their Years either from the *Birth* or *Incarnation* of our *Blessed Saviour*. According to *Dionysius*, the Author of the *Æra* computed from *Christ*, our Saviour was conceived on the Eighth of the *Calends* of *April* (now called *Lady-Day*) in the first of this *Æra*, and was born about the then *Winter Solstice* next following, that is *December* th 25th, and this Account was at first universally received among *Christians*, but is now only used in *Great Britain* and *Ireland*; where, not only the *Ecclesiastick*, but also the *Civil Year* is still reckoned, according to Law, from the Feast of the *Annunciation*, or *Lady-Day*, as it was at first by *Dionysius* himself, whereas, in the other Parts of *Christendom*, (and even in *England*, as to common Affairs) the Year of *Christ* is now reckoned from the first of *January* next before the *Lady-Day*, from which the legal Date of our *Ecclesiastical* or *Civil Year* begins.

There is also another *Æra* frequently made use of by *Christian Writers*, namely, the *Æra* of the *World's Creation*, which is generally believed to be about 3949 Years from the Beginning of the *World* to the *Birth* of *Christ*. *Kepler* makes it 3993 before *Christ*. *Hewelius* says the *World* was created in the 3963 Year Current before *Christ*, the 24th of *October* of the *Julian Year* continued backwards.

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The most ancient and renowned *Epocha* used by the *Heathens*, was that of the *Olympiads* or *Olympick Games*, used among the *Greeks*, which were instituted by one *Pisus*; but *Pelops* the Son of *Tantalus* is much more famous in *History*, who ordered them to be celebrated in Honour of *Jupiter Olympius*, in the *Elean Fields* in the *Peloponnesus*, which is now called *Morea*; the Games lasted five Days, the last whereof fell on the Full Moon, which was next after the *Summer Solstice*.

They were celebrated every fourth Year. The Year wherein the *Olympiad* was celebrated being called the first Year of the said *Olympiad*, and so on.

The Celebration of the first *Olympiad* is referred to the 3938 Year of the *Julian Period*, and consequently to the 776 Year before *Christ*. Any Year of the *Olympiads* being given, to find the corresponding Year before or after *Christ*, work thus; Multiply the compleat *Olympiads* by 4, and to the Product add the Year (if any be specified) of the *Olympiad* running; this Sum, if it be less than 776, subtract it from 776, and the Remainder will shew the corresponding Year before *Christ*; but if the Sum be greater than 776, then subtract 776 from it, and the Remainder will shew the corresponding Year after *Christ*.

Any Year of the *Olympiads* being given, the corresponding Year of the *Julian Period* may be found thus; Multiply the compleat *Olympiads* by 4, and to the Product add the

X 4	Year
9th is 70 - when put down 71 of 9th being of current Olymp. in all writers	

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Year (if any be given) of the *Olympiad* running, and to that Sum add 3937, the *Year* of the *Julian Period*, which was the first of the *Olympiads*; that Sum is the *Year* of the *Julian Period* sought.

Also any *Year* of the *Julian Period* being given, to find out what *Olympick Year* answers thereto, work thus; From the *Year* given, subtract 3937, and divide the Remainder by 4, the *Quotient* will shew the compleat *Olympiads*, and the Remainder will shew the *Year* of the *Olympiad* running; if there be no Remainder, then it is the last or fourth *Year* of the *Olympiad* running.

As the *Account* by the *Olympiads* was the chief *Æra* among the *Greeks*, so the principal *Æra* among the *Romans* was that of the *Building* of *Rome*, which according to *Varro's* Account, began with the *Julian Period* 1961; but according to *Cato*, the City of *Rome* was begun to be built in the *Year* of the *Julian Period* 3962. If therefore, according to *Cato*, 3961 *Years* and 3 *Months*, or according to *Varro*, 3960 *Years* and 3 *Months*, be subtracted from any certain *Year* of the *Julian Period*, the Residue shews the *Year* since the Beginning of the *Epocha* of the *Building* of *Rome*, but if the above-mention'd Numbers be added to the *Time* of the said *Epocha*, the Product will correspond with the *Year* of the *Julian Period*.

The *Argonautic Expedition*, according to *Sir Isaac Newton*, was 927 *Years* before the Birth of *Christ*. *Rome*

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Rome is computed to have been built 627 Years before *Christ*, therefore from 627, subtract any given Year of the *Roman Æra*, or Building of *Rome*, and the Remainder will shew the correspondent Year before *Christ*; or if the Year given of the Building of the City be greater than 627, then subtract 627 from it, and the Remainder will shew the correspondent Year after *Christ*.

Other *Epocha's* or *Æra's* being of less Note and Use to us, it will be sufficient to shew, in short, how long before, or after *Christ* each of them began.

Before *Christ*.

The *Destruction* of *Troy* happened }
in the 3530 Year of the *Julian Pe-* } 1184
riod, Cycle of the Sun 2, Moon 15.

The *Æra* of *Nabonassar*, King of }
Babylon, from the Beginning of whose }
Reign, the *Chaldeans* and *Egyptians* } 747
reckon'd their Years, began *February* }
26, *Julian Period* 3967, Cycle of the }
Sun 19, Moon 15.

The *Æra* of the *Death* of *Alex-* }
ander the Great began *November* 12, } 324
Julian Period 4390, Cycle of the }
Sun 22, Moon 1.

The *Æra* of the *Julian* Reforma- }
tion of the *Calendar* began *January* 1, } 49
Julian Period 4669.

The

After Christ

The *Dioclesian Æra*, or *Æra* of the *Martyrs*, otherwise called the *Æra* of the *Abissinians*, began *August 29*, } 284
A. D.

The *Æra* of the *Hegira* or Flight of *Mahomet*, from *Mecca* to *Medina*, used by the *Turks* and *Arabs*, } 622
 began *July 16*, *A. D.*

The *Æra* of *Yezdegird* or the *Persian Æra*, began *July 16*, *A. D.* } 632

From the *Table* of the Beginning of the forementioned *Æra's*, it is easy to find out the *Year* before or after *Christ*, which answers to any *Year* given of the said *Æra's*, which are computed by *Julian Years*.





Of the EPOCHAS of the Principal Kingdoms of Europe.

I. **G**ERMANY was first made a separate Kingdom, *A. D.* 840, *Julian Period* 5553.

The Title of Emperor of the Romans was first assumed by the King of Germany, 878, *Julian Period* 5601.

The *Austrian Family*, which now enjoys the Imperial Dignity, is descended of *Rodolph, Earl of Hapsburgh and Landgrave of Alsace*, who was chosen Emperor *A. D.* 1273, *Julian Period* 5986.

II. The Gothick Race came first to the Crown of Spain, *A. D.* 410, *Julian Period* 5123.

The Moors dispossessed the Goths, *A. D.* 713, *Julian Period* 5426.

The Moors were totally extirpated out of Spain, *A. D.* 1492. *Julian Period* 6205.

III. Portugal was made a separate Kingdom from Spain, *A. D.* 1139. *Julian Period* 5852. It was united again to Spain, *A. D.* 1580. *Julian Period* 6293.

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Portugal shook off the *Spanish Yoke*, and became once more a *separate Kingdom*, *A. D.* 1640, *Julian Period* 6353.

IV. *France* was first possessed by the *Franks*, and modelled into the Form of a *Kingdom*, *A. D.* 424, *Julian Period* 5137. The first of the present Race of the *Kings of France* mounted the *Throne*, *A. D.* 987, *Julian Period* 5700.

V. In adjusting the *Epocha of England*, we ought to mind the following *Characters*.

1. The *Saxons* invaded *England*, *A. D.* 450. *Julian Period* 5163.

2. King *Egbert* sunk the Distinction of *Saxons* and *Britons*, and called the whole Country *England*, *A. D.* 818. *Julian Period* 5531.

3. The *Danes* possessed the *Crown of England* from 1017 to 1042 of the *Vulgar Epocha of Christ*, *Julian Period* 5755.

4. The *Normans* invaded *England*, *A. D.* 1066, *Julian Period* 5779.

5. The Houses of *Lancaster* and *York* united *A. D.* 1399. *Julian Period* 6112.

6. The *Scots Kings* succeeded to the *Crown of England*, *A. D.* 1601. *Julian Period* 6315.

VI. The *Epocha* of the *Kings of Scotland* commenced with *Fergus the First*, 330 Years before the Birth of *Christ*, in the 4336th Year of

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of the *Julian Period*, in the Time of *Alexander the Great*.

2. *Fergus* the Second, the 40th King of *Scotland* restor'd the *Scots*, after they were almost extirpated by the *Britons* and *Picts*, in the Year of *Christ* 403.

Kenethus the Second, the 69th King of *Scotland*, conquered and extirpated the *Picts* in the Year of *Christ* 834.

3. King *James* the Sixth of *Scotland*, succeeded to the Crown of *England*, and united both Kingdoms into one *A. D.* 1601.

VII. *Sweden* was conquered by *Othin* 24 Years before *Christ*; in the 4690 of the *Julian Period*.

2. *Gustavus Erickson* shook off the *Danish* Yoke, and had the Crown of *Sweden* settled on his Posterity, *A. D.* 1544. *Julian Period* 6267.

VIII. The *Oldenburgh Family* was preferred to the Crown of *Denmark* *A. D.* 1449. *Julian Period* 6162.

IX. *John Czar* of *Muscovy* made *Muscovy* an independant Empire *A. D.* 1470. *Julian Period* 6183.

X. The *Commonwealth* of the Seven United Provinces of the *Netherlands* takes Date from

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from the *Union* concluded at *Utrecht*, *A. D.* 1579. *Julian Period* 6292.

XI. The *Confederate Republick* of *Switzerland* takes Date from the *Year of Christ*, 1320. *Julian Period* 6033.

XII. The Power of the *Waywoods* in *Poland*, was exchanged for that of a *King A. D.* 700. *Julian Period* 5413.

2. These *Kings* were declared independant of the *Empire*, *A. D.* 999. *Julian Period* 5712.

XIII. The *Epocha* of the *Papal Hierarchy* commences from the Time of *Boniface III. Bishop of Rome*, who assumed the *Title* of *OEcumenical Bishop A. D.* 606, *Julian Period* 5219.

XIV. The *Epocha* of the *Reformation* takes its Date from the 1517 *Year* of the *Vulgar Epocha of Christ*; and of the *Julian Period* 6230, that being the *Year* in which *Luther*, the first *Reformer*, wrote against *Indulgences*.



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